Synthesis of Fluorobenzyl Alkylators: Studies Toward Realkylation of Aged Acetylcholinesterase

Undergraduate Research Thesis
Presented in Partial Fulfillment of the Requirements for graduation *with Honors Research Distinction* in Chemistry in the undergraduate colleges of The Ohio State University

by
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ABSTRACT

Acetylcholinesterase (AChE) is an enzyme found in the central nervous system that is responsible for hydrolyzing acetylcholine into choline and acetic acid. Organophosphorus compounds (OPs) like tabun and sarin are used as pesticides and chemical warfare agents. These OPs covalently bond to the oxygen in the Serine-203 residue in the active site of AChE resulting in inhibition of the enzyme. There are known therapeutics, pyridinium oximes, that can reverse this inhibition and reactivate the AChE if administered within the aging time frame. If left untreated, AChE complex will undergo an irreversible process where the oxygen attached to the phosphorus loses its alkyl group. This highly stable inhibited enzyme is said to be "aged," and does not respond to the pyridinium oximes. There are currently no pharmaceuticals to reverse this aging process. Without functioning AChE, acetylcholine builds up and can lead to serious adverse health effects such as vomiting, paralysis, and eventual death by respiratory failure. The aging process can vary from minutes to hours depending on the toxicity of the specific OP. Our research focuses on synthesizing a small organic compound that can re-alkylate the aged enzyme. Quinone methide precursors (QMPs) are of interest because they are similar to other molecules that bind to the active site of AChE. QMPs have previously been shown to act as electrophiles for alkylations in biological systems. The use of computational modeling has helped us design the QMPs to be synthesized. The synthesis and initial kinetic testing of electron withdrawing re-alkylators will be discussed.

ACKNOWLEDGEMENTS

I would like to thank my organic chemistry professor and research advisor Dr. Christopher Callam. His enthusiasm for teaching and organic chemistry inspired my passion for organic chemistry and research. I would also like to thank him and Dr. Christopher Hadad for giving me the opportunity to conduct research in their lab. I have learned a lot over the past year and this experience has inspired me to continue doing research in medical school.

I would like to thank Qinggeng (Albert) Zhuang for performing the initial kinetic screening on my compounds and for teaching me how the kinetic screenings work. I would also like to thank the other graduate students in the group, Tom, Ryan, Amneh, Andrew and Bill, for their guidance and help over the past year.

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I would like to thank my family for their support during my college career and for their continued support in the next four years. I would not be able to succeed without their love and support.

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1. Introduction

Organophoshorus compounds (OPs) are used as pesticides and chemical warfare agents and remain a great concern. Chemical warfare agents are defined as compounds that can generate a toxic effect through vesicant, poisonous, or asphyxiating gases. In contrast, biological warfare utilizes microorganisms to cause disease in plants and animals. The use of chemical warfare agents can be traced back to 1,000 B.C. The Chinese used gases that contained arsenic and the Greeks would poison the water of their enemies with chemical compounds. Modern chemical warfare began in World War I, where the German forces utilized chlorine gas against the Allies. British and French troops fought back with other poisonous gases like phosgene, diphosgene, hydrogen cyanide, cyanogen chloride and mustard gas.[1]

Gerhard Schrader first developed organic phosphorus nerve agents while trying to synthesize pesticides. He synthesized a large quantity of the compounds. Germany altered Schrader's research from pesticides to chemical warfare agents once the toxicity of the compounds were known. He later synthesized the "G agents," which are tabun, sarin, and soman (*Figure 1.1)*. The Germans continued to synthesize the organophosphorus compounds. After the Allies won Word War II, Russian troops found about 1200 tons of tabun, 600 tons of sarin, and an unknown amount of soman at a nerve gas factory in Dührernfurth. The Germans did not utilize the OP nerve agents against the allies. The reason is unclear, but people speculate that the Germans thought that the allies had more dangerous chemical warfare agents that they could use in defense. After the discovery of the German stockpiles, the United States and Britain started to synthesize their own

chemical nerve agents.[2] The British developed the "V series" which were more stable than the German's "G series.[3]

Although the nerve agents were not utilized in World War II, they have been used in other conflicts. In the 1980 Iran-Iraq War, the Iraqis used an OP nerve agent against the Iranians in the battlefield. They also deployed the nerve agent on the Kurdish civilian population of Halabja. This attack killed about 5,000 people.[4] A Japanese cult used sarin in their attacks in Matsumoto city in 1994 and again in the Tokyo subway system in 1995. This caused 5,500 injuries and 12 deaths. Nerve agents were used as an act of terrorism in these two events.[5] More recently, the Syrians deployed the toxic nerve agents against their own people in the 2013 Syrian civil war.[6] Today it is estimated that 3 million people still come into contact with OP compounds each year, which results in around 300,000 deaths.[7]

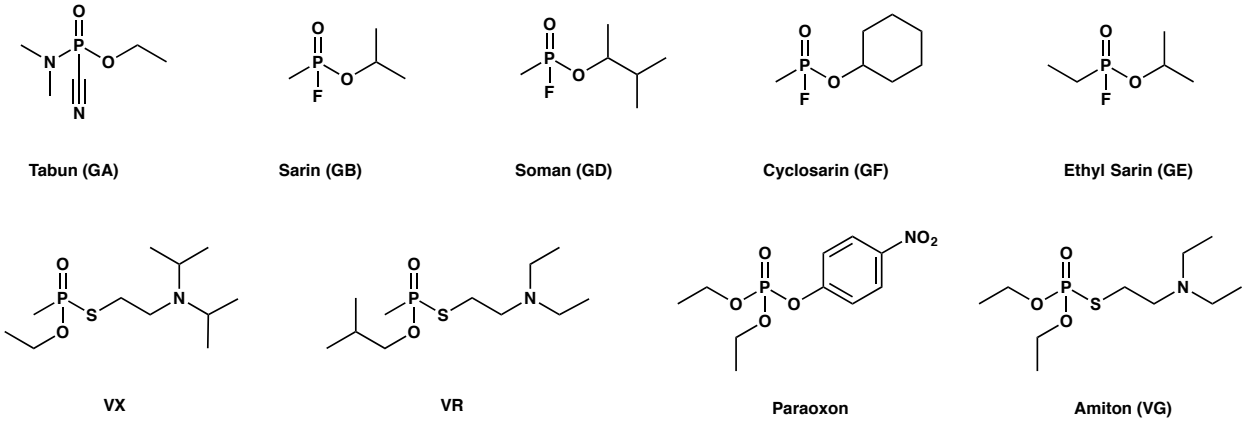
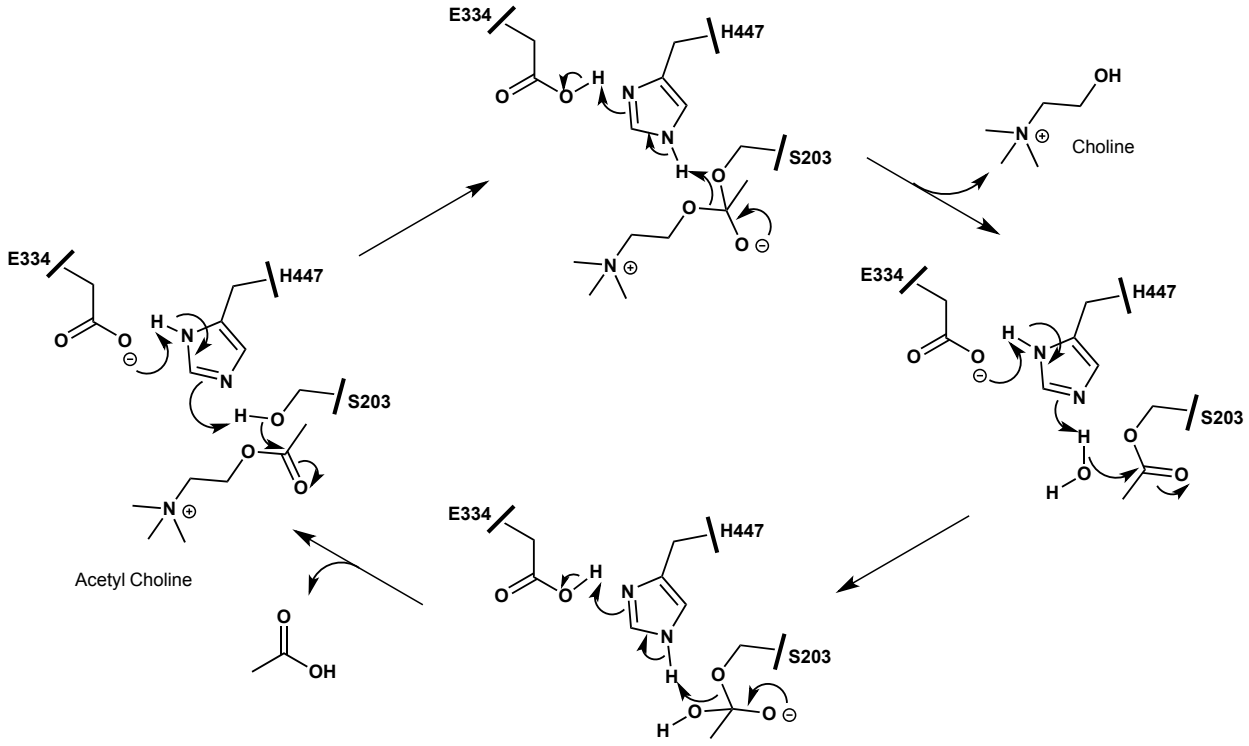


Figure 1.1: Common OP compounds used as chemical warfare agents and pesticides.

OP nerve agents are a great concern because of their commercial availability, large stockpiles, and their adverse affects in the body. OP nerve agents covalently inhibit the enzyme, acetylcholinesterase (AChE). AChE is an important enzyme found in the central

nervous system that is responsible for regulating acetylcholine (ACh) by hydrolyzing it into choline and acetic acid via a catalytic triad of glutamate, serine, and histidine residues. (*Scheme 1.1*)[8] After exposure, the OP covalently bonds to the serine residue, which inhibits the enzyme and results in an accumulation of acetylcholine in the neurosynaptic junctions.[9] An excess of acetylcholine can lead to multiple adverse affects like muscle twitching, reduced vision, paralysis, vomiting, and convulsions. Ultimately, death by respiratory failure occurs, and can be immediate if the concentration of the nerve agent is high.[3]



Scheme 1.1: The hydrolysis of acetylcholine (ACh) into acetic acid and choline via AChE.

There are known therapeutics, pyridinium oximes, that can reverse this inhibition and reactivate the inhibited AChE.[9] If left untreated, AChE-OP complex will undergo an irreversible process where the oxygen attached to the phosphorus loses its alkyl group (*Figure 1.2*). At this time the enzyme is said to be "aged" and acetylcholine continues to

build up.[10] The time it takes the enzyme to age can vary from minutes to days depending on the type and the size of the OP. There are currently no pharmaceuticals to reverse the aging process.[11]

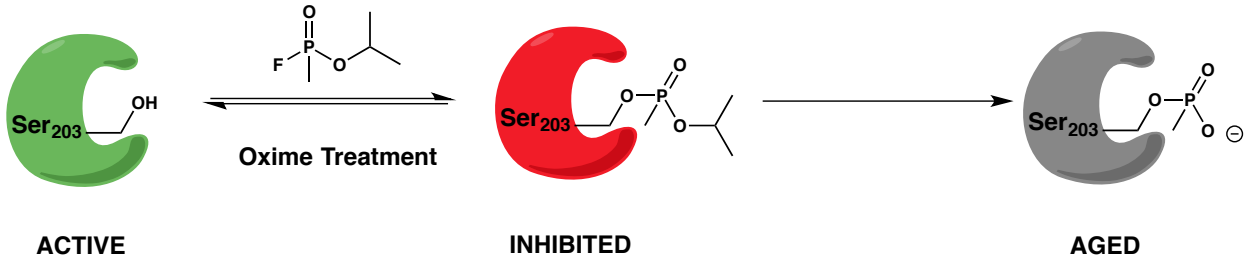


Figure 1.2: The aging process of AChE.

The main focus of this research project is to synthesize a small compound that can re-alkylate the aged enzyme to the inhibited form, so that a pyridinium oxime can be used for treatment and reactivation. The compound must have alkylating properties and have an affinity towards AChE's active site. Quinone methides (QMs) are of particular interest because of their electrophilic properties. QMs are highly reactive because of its ability to act as a Michael acceptor and the driving force of the QM to return to aromaticity.[12, 13, 14] There are three different types of QMs, which are the *ortho*-QM, *para*-QM, and *meta*-QM (*Figure 1.3*).

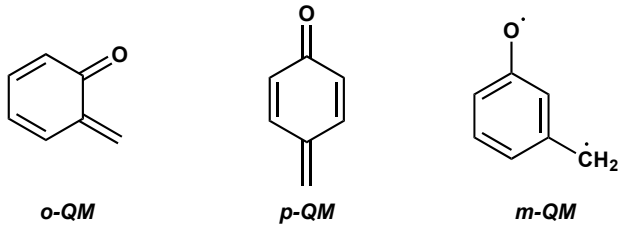
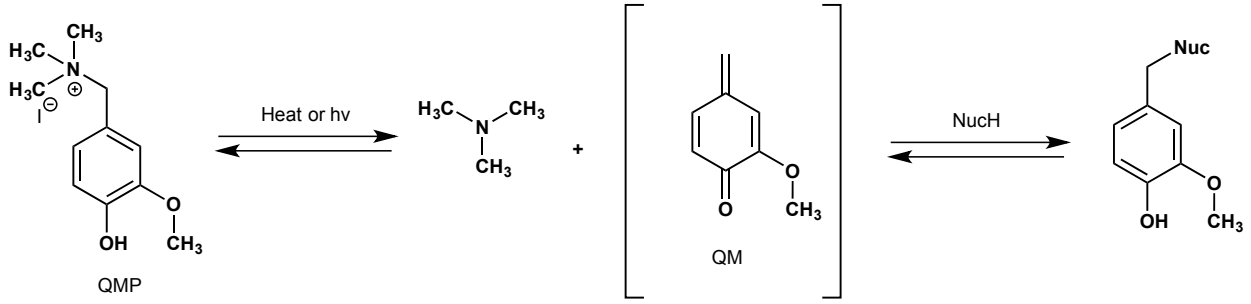


Figure 1.3: General structure of QM.

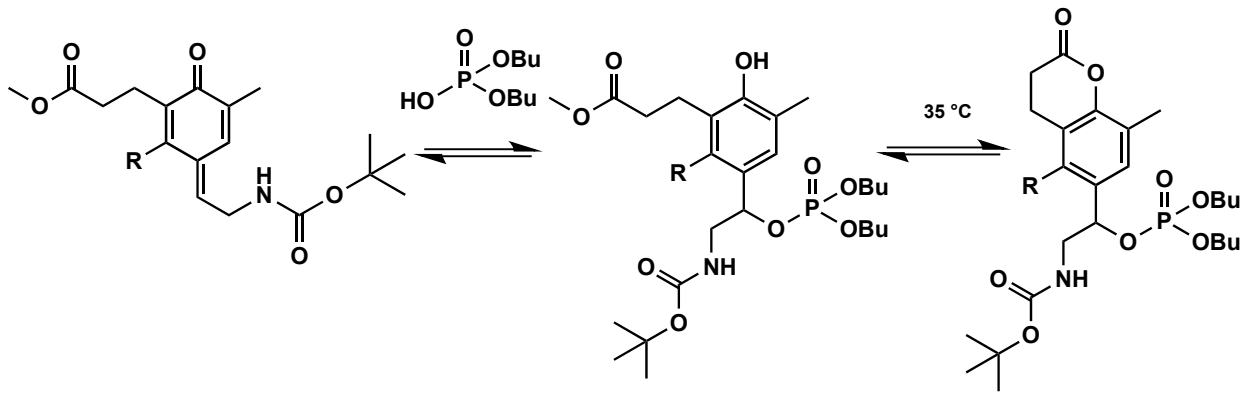
Modica et al. conducted a study that determined that QMs had the ability to alkylate various nucleophiles like amino acids, thiols, and water. The QM was generated from a quinone methide precursor (QMP) by thermal or photochemical means. The QMP is shown as a benzyl ammonium salt that loses the amine leaving group to form the high energy QM. The formation of QMs and their reactivity with a nucleophile were studied under physiological conditions via thermal and photochemical methods (*Scheme 1.2*).[15]



NucH is H_2O, amines, thiols, Gly, Ser, Lys, Tyr, Cys, and Glutathione

Scheme 1.2: Formation of the QM to alkylate a nucleophile.

Another study from Bakke et al. showed the alkylating properties of the QMs. The QMs were formed by an oxidation reaction with lead (II) oxide and silver (I) oxide from QMPs. The experiment showed that the QM re-alkylated a phosphodiester bond and lactonized to form a trialkyl phosphate under aqueous conditions[16] (*Scheme 1.3*). This study is important and gave inspiration for our current research. The OP compound forms a phosphodiester bond with the Ser-203 residue of AChE. It is hypothesized that the QMs will have the ability to re-alkylate the aged enzyme based on literature review that was discussed.



Scheme 1.3: QM alkylates a phosphodiester bond followed by lactonization.

There is an infinite amount of QMPs and QMP like molecules that can be synthesized and tested to re-alkylate the aged AChE enzyme. Computational chemistry narrows the options of QMPs to be synthesized and tested. Computational methods determined the reactivity and the docking pose of the QMPs in the enzyme's active site.[17] Computational chemistry guided the synthetic efforts. This thesis will concentrate on the synthesis of electron withdrawing re-alkylators, specifically fluorobenzyl and α,α,α-trifluoromethyl-benzyl compounds.

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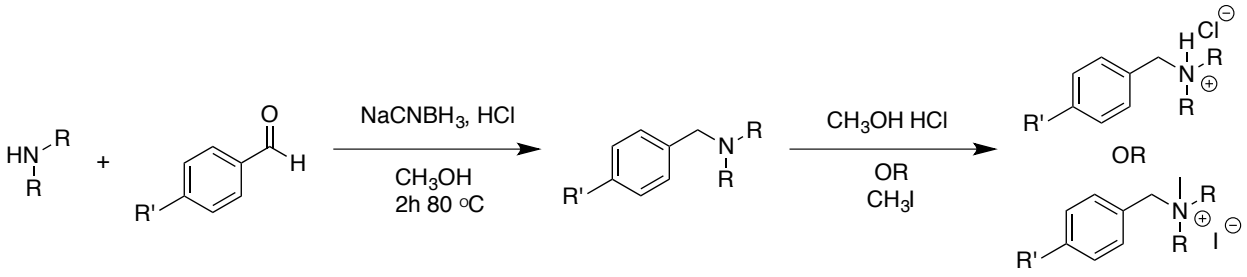
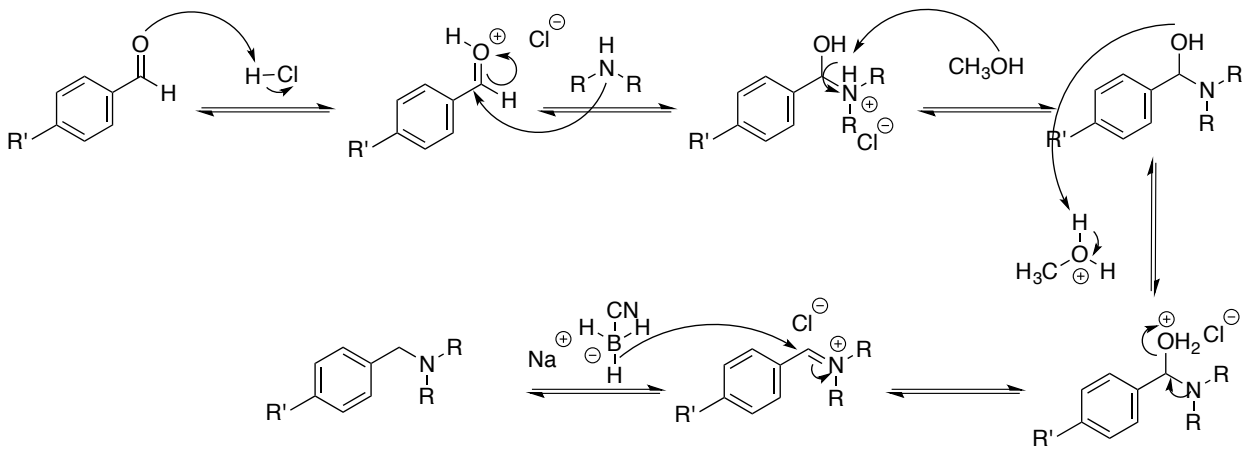
2. SYNTHESIS

2.1 Synthesis of Fluorobenzyl and α,α,α-trifluoromethylbenzyl re-alkylators



Scheme 2.1: General scheme for the two step synthesis of the ammonium salt re-alkylator.

The synthesis of the ammonium salt re-alkyltors was derived from the corresponding aldehyde, which was commercially available. The two-step synthesis shown in Scheme 2.1 allowed for a convenient and cost effective assembly of the corresponding ammonium or alkylammonium salts. The common synthetic protocol used involves a reductive amination to achieve the corresponding amine. The normal procedure involved mixing of the aldehyde (1 equiv.) with the secondary amine (1.5 equiv.), HCl (conc.) and sodium cyanoborohydride (1.1 equiv.) followed by reflux for 2 h to produce the crude amine. The crude amine was isolated. It was then either re-dissolved in toluene (7.5 mL) and methanolic HCl, or CH_3I was added to isolate the ammonium or alkyl ammonium salt.



Scheme 2.2: Proposed mechanism of a reductive amination between a general aldehyde and amine.

The mechanistic representation of the reductive amination is shown in Scheme 2.2. The carbonyl oxygen first undergoes an acid/base step where the electrons on the oxygen attack the hydrogen. The carbonyl oxygen is now protonated and the carbonyl carbon is more electrophilic. The nitrogen on the secondary amine participates in a nucleophilic attack of the carbonyl carbon. The amine salt is deprotonated and then the oxygen is protonated in a series of acid base steps. The electrons on nitrogen eliminate the water forming an iminium salt. The sodium cyanoborohydride is a source of a hydride ion that selectively reduces the iminium ion and generates the amine.

Through two synthetic steps, shown in *Scheme 2.1*, varying yields were achieved as shown in *Table 2.1*.

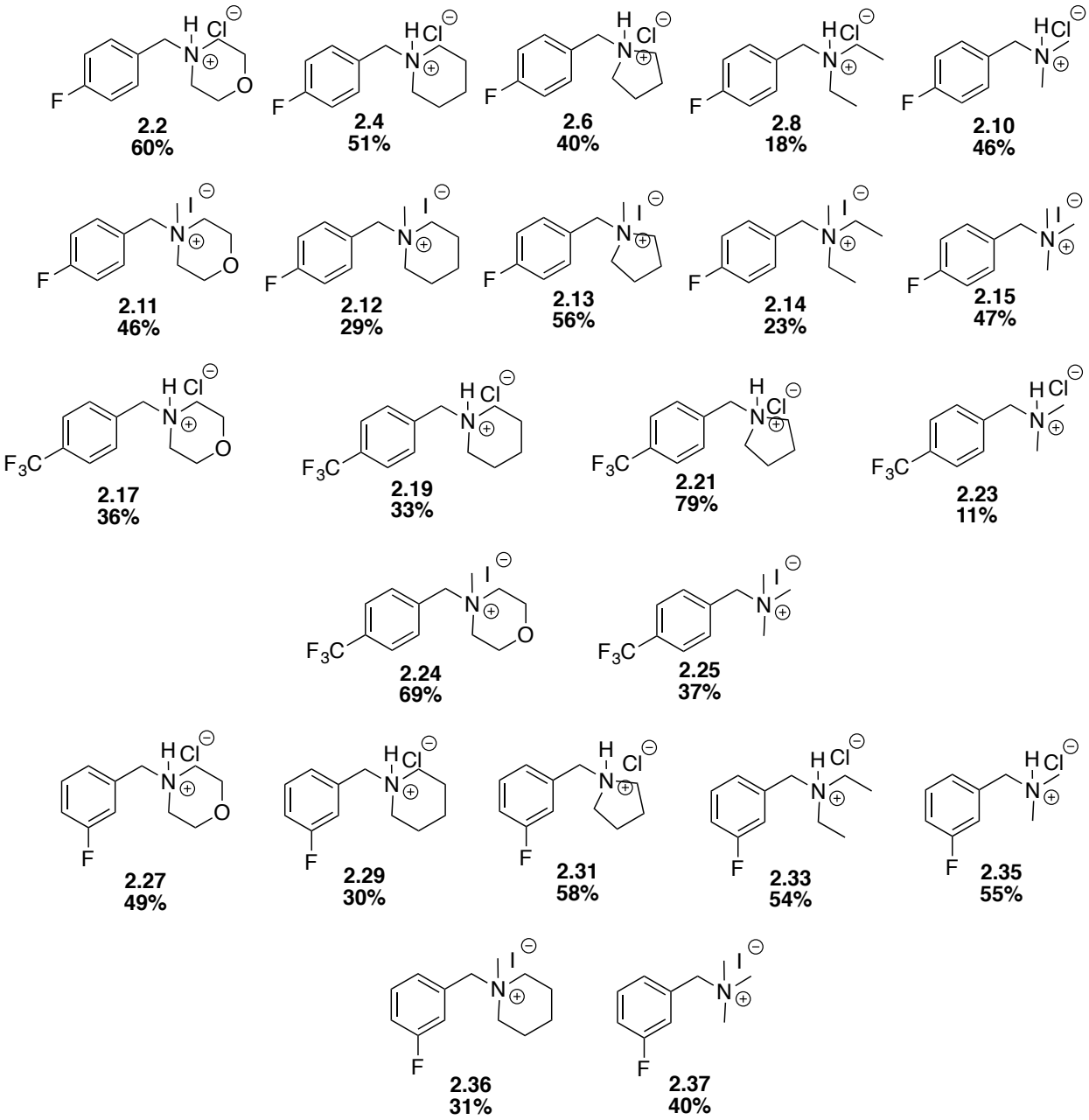
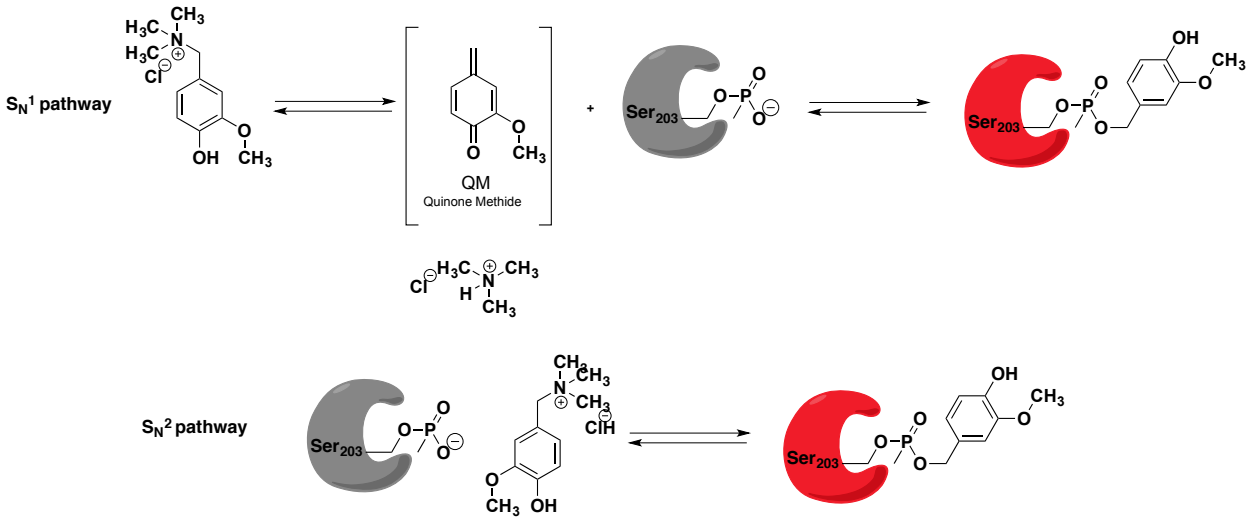


Table 2.1: Fluorobenzyl and α,α,α-trifluoromethylbenzyl alkylators and synthetic yields.



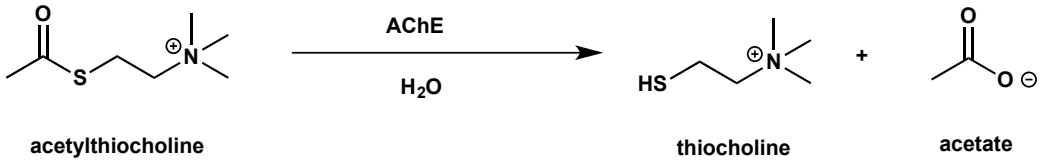
Scheme 2.3: S_N1 and S_N2 pathway of a general QMP with a nucleophile

In the presence of a nucleophile, the QMP will either follow a S_N1 or S_N2 pathway (*Scheme 2.3*) to react with the negatively charged nucleophile. In the S_N1 pathway, the amime salt leaves forming a highly reactive QM. The nucleophile attacks the electrophilic carbon of the QM. In the $S_N2$pathway, the nucleophile attacks the benzylic carbon and then the amine leaving group leaves in a concerted mechanism. Both pathways end with the same compound in the end. The S_N2 pathway is the pathway that would occur with flourobenzyl compounds since there is not a phenol group present on the ring. The fluorobenzyl compounds do not have the ability to convert into a QM, but could still follow the $S_N2$pathway and re-alkylate the aged acetylcholinesterase (nucleophile). The electron withdrawing groups should increase the electrophilicty of the benzylic carbon.

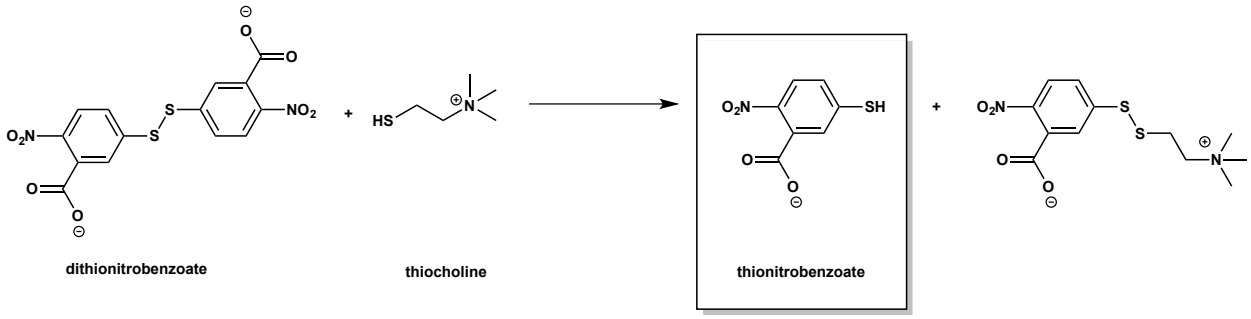
2.2 Initial Kinetic Testing of Realkylators.

The purified alkylators were subject to an initial kinetic testing. The activity of active acetylcholinesterase (AChE) can be monitored by Ellman's Assay. In Ellman's assay,

acetylthiocholine is hydrolyzed to thiocholine (*Scheme 2.4)* instead of acetylcholine hydrolyzing to choline. Thiocholine will then cleave the disulfide bond in dithionitrobenzoate to form thionitrobenzoate and another by-product (*Scheme 2.5).* The concentration of thionitrobenzoate can be monitored via ultraviolet–visible spectroscopy because thionitrobenzoate absorbs light at 412 nm. Since the concentration of thionitrobenzoate can be monitored, the activity of the enzyme can be determined.[1]



Scheme 2.4: The reaction of acetylthiocholine hydrolysis to thiocholine.



Scheme 2.5: The reaction of thiocholine and dinitrobenzoate in an Ellman's assay.

The fluorobenzyl alkylators were incubated with aged electric eel AChE and ammonium fluoride for 2 days at 37 °C (*Figure 2.1*). Ammonium fluoride acts like the pyridinium oxime and reactivates the inhibited AChE. The native AChE is then monitored by Ellman's assay.

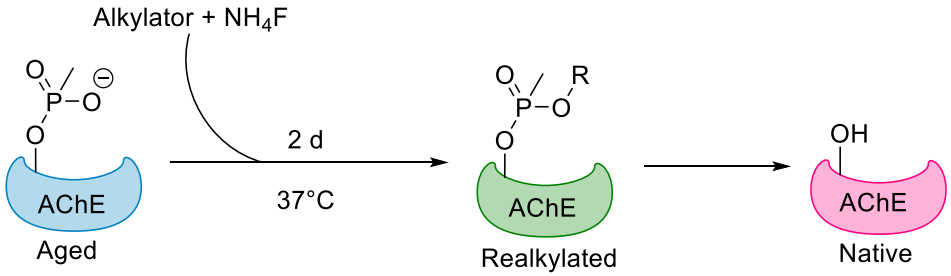


Figure 2.1: The initial kinetic screening pathway.

The results from the initial screening are shown below in *Figure 2.2*. The bar on the far left is the negative control, which consists of aged AChE and NH_4F, and the bar on the far right is the positive control, which consist of native AChE and NH_4F. The y-axis refers to the activity of the enzyme and the x-axis refers to the different alkylators that were tested. The percent activity is low (under 1%), but it is still above the negative control.

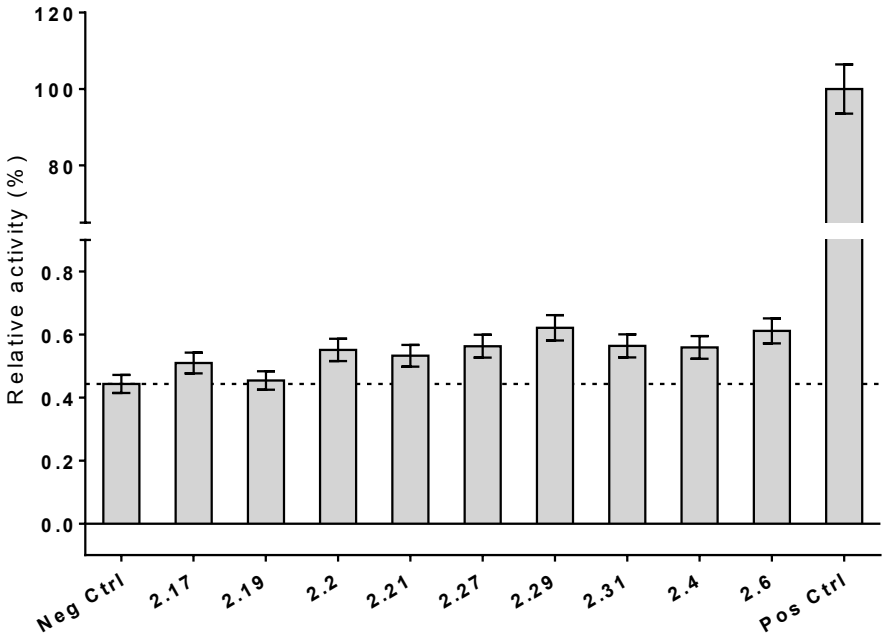


Figure 2.2: Aged AChE's activity with incubation of a protonated re-alkylator and NH_4F for 2 days.

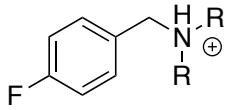
	Amine	Compound Number	Relative Activity (%)
	Morpholine	**2.2**	0.55
	Piperidine	**2.4**	0.56
	Pyrrolidine	**2.6**	0.61

Table 2.2: Relative activity of AChE and the 4-fluorobenzyl protonated alkylators

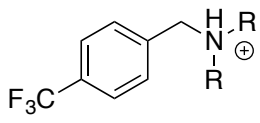
	Amine	Compound Number	Relative Activity (%)
	Morpholine	**2.17**	0.51
	Piperidine	**2.19**	0.45
	Pyrrolidine	**2.21**	0.53

Table 2.3: Relative activity of AChE and the α,α,α-trifluoromethyl-benzyl protonated alkylators

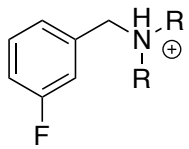
	Amine	Compound Number	Relative Activity (%)
	Morpholine	**2.27**	0.56
	Piperidine	**2.29**	0.62
	Pyrrolidine	**2.31**	0.56

Table 2.4: Relative activity of AChE and the 3-fluorobenzyl protonated alkylators

The relative activity of the aged enzyme after incubation with the alkylator and reactivator (NH_4F) was reported for each compound. The 3-fluorobenzyl protonated

alkylators seemed to have a higher percent of activity of the enzyme compared to the other two families. The α,α,α-trifluoromethyl-benzyl protonated alkylators had the lowest percent of activity of the enzyme compared to the other two families. When the amine leaving group was pyrrolidine, the relative activity of the enzyme was increased for α,α,α-trifluoromethyl-benzyl and 4-fluorobenzyl.

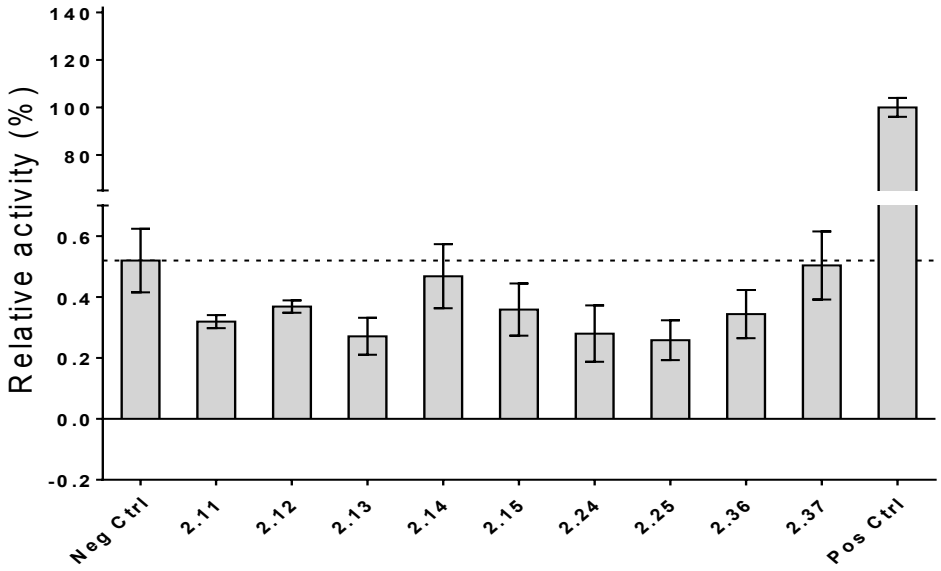


Figure 2.3: Aged AChE's activity with incubation of a protonated re-alkylator and NH_4F for 2 days.

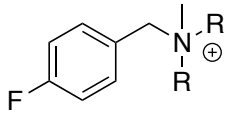
	Amine	Compound Number	Relative Activity (%)
	Morpholine	**2.11**	0.32
	Piperidine	**2.12**	0.37
	Pyrrolidine	**2.13**	0.27
	Diethyl	**2.14**	0.47
	Dimethyl	**2.15**	0.36

Table 2.5: Relative activity of AChE and the 4-fluorobenzyl methylated alkylators.

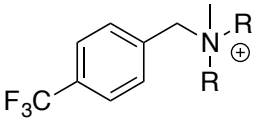
	Amine	Compound Number	Relative Activity (%)
	Morpholine	**2.24**	0.28
	Dimethyl	**2.25**	0.26

Table 2.6 Table 2.3: Relative activity of AChE and the **α,α,α**-trifluoromethyl-benzyl methylated alkylators.

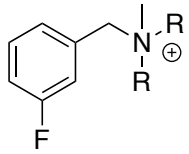
	Amine	Compound Number	Relative Activity (%)
	Piperidine	**2.36**	0.34
	Dimethyl	**2.37**	0.50

Table 2.7: Relative activity of AChE and the 3-fluorobenzyl methylated alkylators.

It is difficult to compare the relative activities between the aldehyde families and the amine because the amines were not all successfully synthesized. The relative activity of the methylated alkylators was less than the negative control. The protonated alkylators did much better with the aged enzyme than the methylated alkylators. The only compound that showed the same amount of relative activity as the negative control was the dimethyl amine with the 3-fluorobenzyl.

2.3 General. The solvents used in this experiment were not purified any further. All the reactions were carried out at standard atmospheric pressure and monitored via TLC on silica gel 60 F254 (0.25 mm, E.Merck). The compounds were detected with a UV lamp. The final products were characterized using ^{1}H NMR and ^{13}C NMR. ^{1}H NMR spectra were recorded at 400MHz and referenced to 4.87 for D_2O. ^{13}C NMR spectra were recorded at 100.6 MHz and referenced to 49 for CD_3OD.

2.4 General Procedure for Protonation Reactions.

Part 1: A suspension of amine (1.5 equiv.) and methanol (20 mL) was stirred while hydrochloric acid (0.35 mL) was added drop-wise over 3 min. The aldehyde (1 equiv.) and sodium cyanoborohydride (1.1 equiv.) was added and reacted at 80 °C for 2 h. Distilled water (30 mL) was added to the reaction mixture. The mixture was extracted with dichloromethane (3x40 mL). The organic layer was separated, dried with sodium sulfate, and evaporated under reduced pressure to yield a crude neutral amine product as an oil. The neutral amine product was used in the next step without purification.

Part 2: A portion of crude oil was dissolved in toluene (7.5 mL) and hydrochloric acid in methanol (2 M, 1 mL) was added. The reaction was stirred for 1 h at 23 °C. The suspension was evaporated under reduced pressure. The remaining solid was triturated with acetone/petroleum ether (20 mL, 1:1 ratio) to yield the protonated amine as a white solid.

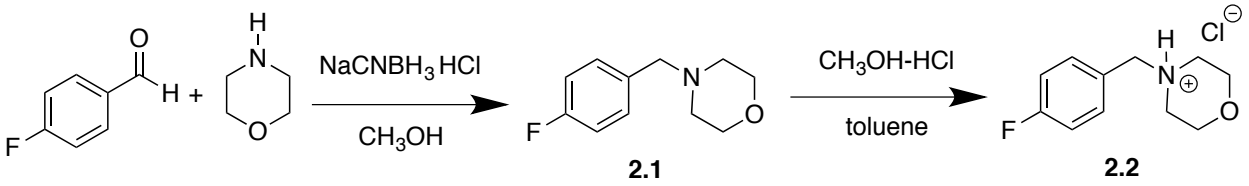
2.5 General Procedure for Alkylation Reactions.

Part 1: A suspension of amine (1.5 equiv.) and methanol (20 mL) was stirred while hydrochloric acid (0.35 mL) was added drop-wise over 3 min. The aldehyde (1 equiv.) and

sodium cyanoborohydride (1.1 equiv.) were added and reacted at 80 °C for 2 h. Distilled water (30 mL) was added to the reaction mixture. The mixture was extracted with dichloromethane (3x40 mL). The organic layer was separated, dried with sodium sulfate, and evaporated under reduced pressure to yield a crude neutral amine product as an oil. The neutral amine product was used in the next step without purification.

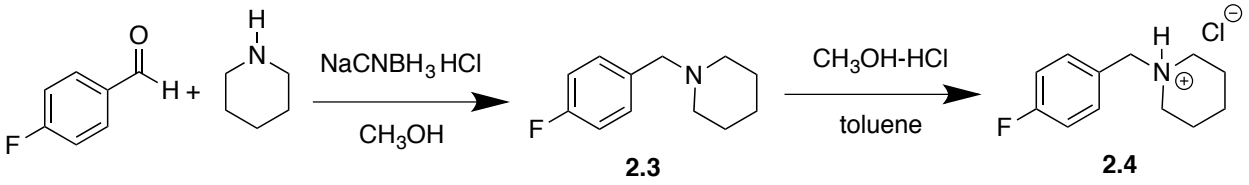
Part 2: A portion of the crude oil and methyl iodide reacted at 23 °C for 24 h. The solid was triturated with acetone/petroleum ether (20 mL, 1:1 ratio) to yield the alkylated amine as a white solid.

2.6 Reactions with 4-fluorobenzaldehyde.



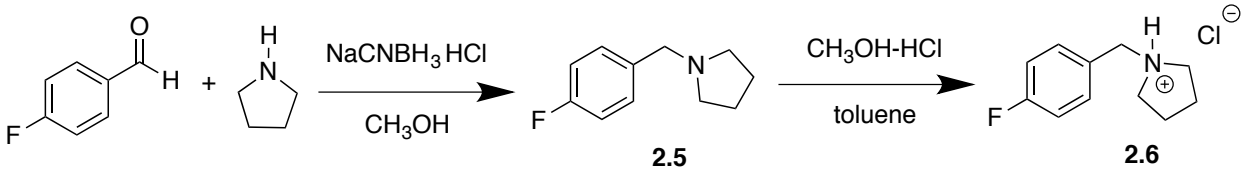
Scheme 2.6: Reductive amination between morpholine and 4-fluorobenzaldehyde followed by protonation.

General procedure 2.4 was followed. Morpholine (0.5264 g, 6.043 mmol, 0.52 mL) reacted with 4-fluorobenzaldehyde (0.5 g, 4.029 mmol, 0.43 mL) and sodium cyanoborohydride (0.2785 g, 4.43 mmol) to yield **2.1** as a light yellow oil. A portion of **2.1** (0.9257 g, 4.741 mmol) was protonated to yield **2.2** as a white solid (0.5554 g, 60%). **(2.2):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.74-7.64 (m, 2H), 7.31-7.22 (m, 2H), 4.46-4.40 (m, 2H), 4.15-3.79 (m, 4H), 3.45-3.18 (m, 5H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 166.42, 163.94, 135.03, 125.88, 117.26, 64.84, 60.97, 52.71, 44.64.



Scheme 2.7: Reductive amination between piperidine and 4-fluorobenzaldehyde followed by protonation.

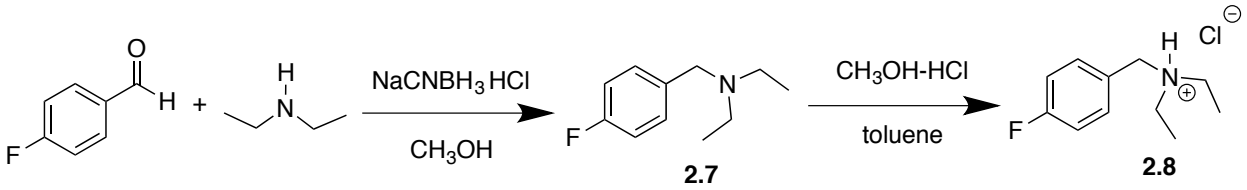
General procedure 2.4 was followed. Piperidine (0.5146 g, 6.043 mmol, 0.60 mL) reacted with 4-fluorobenzaldehyde (0.5 g, 4.029 mmol, 0.43 mL) and sodium cyanoborohydride (0.2785 g, 4.43 mmol) to yield **2.3** as a yellow oil. A portion of **2.3** (0.7829 g, 4.051 mmol) was protonated to yield **2.4** as a white solid (0.4746 g, 51%). **(2.4):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.28-7.60 (m, 2H), 7.26-7.18 (m, 2H), 4.32 (s, 2H), 3.35-2.94 (m, 4H), 1.94-1.59 (m, 7H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 166.29, 163.82, 134.89, 126.63, 117.16, 60.75, 53.86, 45.74, 23.69, 23.05.



Scheme 2.8: Reductive amination between pyrrolidine and 4-fluorobenzaldehyde followed by protonation.

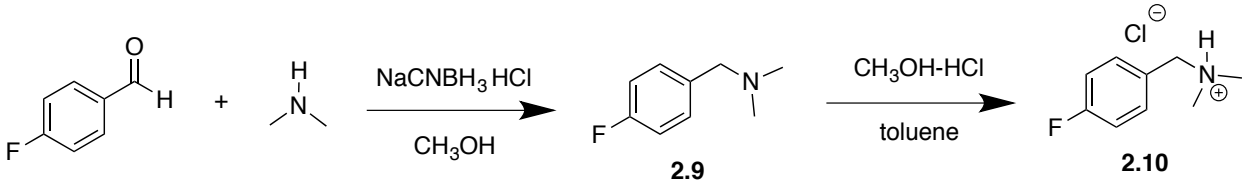
General Procedure 2.4 was followed. Pyrrolidine (0.4298 g, 6.043 mmol, 0.50 mL) reacted with 4-fluorobenzaldehyde (0.5 g, 4.029 mmol, 0.43 mL) and sodium cyanoborohydride (0.2785 g, 4.43 mmol) to yield **2.5** as a yellow oil. A portion of **2.5** (0.7138 g, 3.982 mmol) was protonated to yield **2.6** as a white solid (0.3436 g, 40%). **(2.6):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.71-7.61 (m, 2H), 7.27-7.19 (m, 2H), 4.44 (s, 2H), 3.58-3.16 (m, 4H), 2.27-1.99

(m, 4H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 166.17, 163.71, 133.96, 128.29, 117.23, 58.28, 54.69, 23.81.



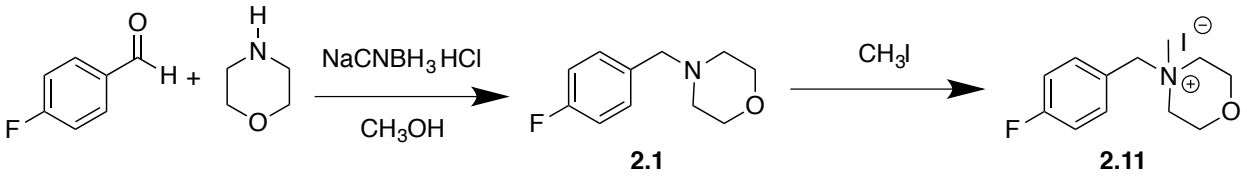
Scheme 2.9: Reductive amination between diethylamine and 4-fluorobenzaldehyde followed by protonation.

General Procedure 2.4 was followed. Diethylamine (0.88 g, 12.09 mmol, 1.25 mL) reacted with 4-fluorobenzaldehyde (1.0 g, 8.057 mmol, 0.86 mL) and sodium cyanoborohydride (0.557 g, 8.86 mmol). An additional equivalence of sodium cyanoborohydride (0.2785 g, 4.43 mmol), hydrochloric acid (0.18 mL), and diethylamine (0.44 g, 6.045 mmol, 0.63 mL) was added and reacted for 2 h at 80 °C to yield **2.7** as a light brown oil. A portion of **2.7** (0.5890 g, 3.25 mmol) was protonated. The product was purified via a column to yield **2.8** as a white solid (0.1269 g, 18%). **(2.8):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.59-7.54 (m, 2H) 7.27-7.22 (m, 2H), 4.32 (s, 2H), 3.23-3.16 (q, 4H), 1.38-1.32 (t, 6H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 210.05, 163.81, 134.27, 117.40, 56.41, 47.85, 30.65, 9.07.



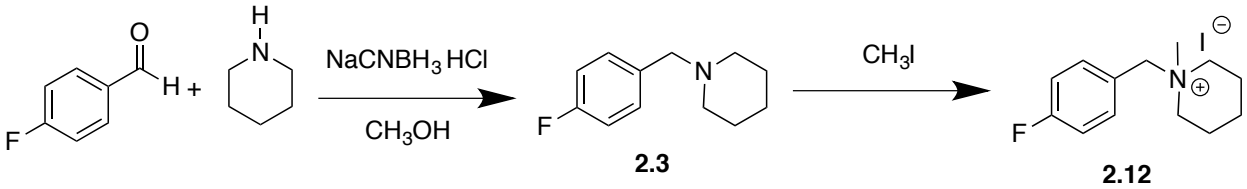
Scheme 2.10: Reductive amination between dimethylamine and 4-fluorobenzaldehyde followed by protonation.

General Procedure 2.4 was followed. Dimethylamine (2 M, 12.09 mmol, 6 mL) was reacted with 4-fluorobenzaldehyde (1 g, 8.06 mmol, 1.0 mL) and sodium cyanoborohydride (0.557 g, 8.86 mmol) at 70 °C to yield **2.9** as a light yellow oil. A portion of **2.9** (0.57 g, 3.721 mmol) was protonated to yield **2.10** as a white solid (0.3235 g, 46%). **(2.10):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.59-7.52 (2H, m), 7.27-7.20 (2H, m), 4.31 (s, 2H), 2.84 (s, 6H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 166.44, 163.97, 134.46, 127.19, 117.40, 61.33, 42.89.



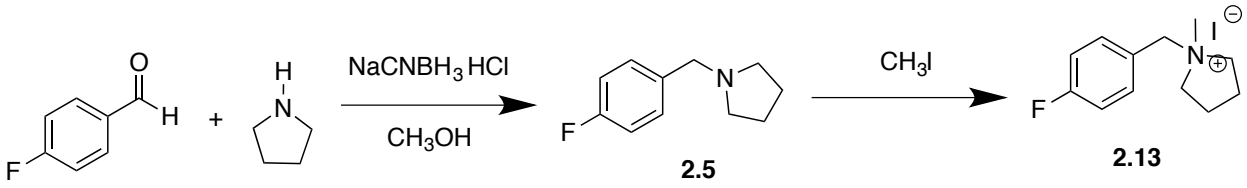
Scheme 2.11: Reductive amination between morpholine and 4-fluorobenzaldehyde followed by alkylation.

General Procedure 2.5 was followed. Morpholine (1.053 g, 18.13 mmol, 1 mL) was reacted with 4-fluorobenzaldehyde (1.5 g, 12.09 mmol, 1.3 mL) and sodium cyanoborohydride (0.8357 g, 13.3 mmol) to yield **2.1** as a light yellow oil. A portion of **2.1** (0.6299 g, 3.226 mmol) reacted with methyl iodide (1.374 g, 9.678 mmol, 0.6 mL) to yield **2.11** as a white solid (0.4972 g, 46%). **(2.11):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.71-7.64 (m, 2H), 7.35-7.27 (m, 2H), 4.72 (s, 2H), 4.14-4.00 (m, 4H), 3.70-3.37 (m, 4H), 3.17 (s, 3H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 166.83, 164.34, 136.86, 124.04, 117.40, 69.44, 61.63, 60.55, 52.72, 46.53.



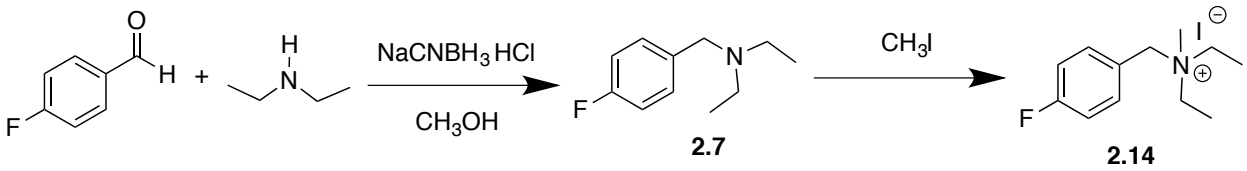
Scheme 2.12: Reductive amination between piperidine and 4-fluorobenzaldehyde followed by alkylation.

General Procedure 2.5 was followed. Piperidine (1.544 g, 18.13 mmol, 1.8 mL) was reacted with 4-fluorobenzaldehyde (1.5 g, 12.09 mmol, 1.3 mL) and sodium cyanoborohydride (0.8357 g, 13.3 mmol) to yield **2.3** as a yellow oil. A portion of **2.3** (0.9122 g, 4.72 mmol) reacted with methyl iodide (2.010 g, 14.20 mmol, 0.88 mL) to yield **2.12** as a white solid (0.4580 g, 29%). **(2.12):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 8.70-8.63 (m, 2H), 8.33-8.27 (m, 2H), 5.63 (s, 2H), 3.18 (s, 13H), 3.03 (s, 3H), 2.07-1.99 (m, 4H), 1.99-1.92 (m, 10H), 1.77-1.66 (m, 6H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 166.70, 164.21, 136.71, 124.69, 117.27, 68.11, 64.03, 52.56, 47.23, 21.28. Contaminated with a piperidine-CH_3I salt.



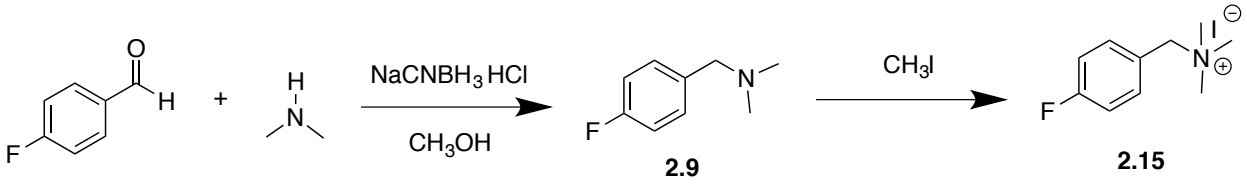
Scheme 2.13: Reductive amination between pyrrolidine and 4-fluorobenzaldehyde followed by alkylation.

General Procedure 2.5 was followed. Pyrrolidine (1.289 g, 18.13 mmol, 1.5 mL) was reacted with 4-fluorobenzaldehyde (1.5 g, 12.09 mmol, 1.3 mL) and sodium cyanoborohydride (0.8357 g, 13.3 mmol) to yield **2.5** as a yellow oil. A portion of **2.5** (0.84 g, 4.69 mmol) reacted with methyl iodide (1.996 g, 14.05 mmol, 0.88 mL) to yield **2.13** as a white solid (0.8468 g, 56%). **(2.13):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.77-7.65 (m, 2H), 7.35-7.26 (m, 2H)4.74-4.60 (m, 2H), 3.81-3.46 (m, 4H), 3.09-3.01 (m, 3H), 2.43-2.24 (br s, 4H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 166.58, 164.10, 136.06, 126.03, 117.31, 66.68, 64.66, 22.26, 17.96.



Scheme 2.14: Reductive amination between diethylamine and 4-fluorobenzaldehyde followed by alkylation.

General Procedure 2.5 was followed. Diethylamine (1.289 g, 18.13 mmol, 1.5 mL) was reacted with 4-fluorobenzaldehyde (1.5 g, 12.09 mmol, 1.3 mL) and sodium cyanoborohydride (0.8357 g, 13.3 mmol). A second portion of diethylamine (0.95 mL), hydrochloric acid (0.25 mL), and sodium cyanoborohydride (0.417 g) was added and reacted for an additional 2 hours at 80 °C to yield **2.7** as a light brown oil. A portion of **2.7** (0.5717 g, 3.15 mmol) reacted with methyl iodide (0.6716 g, 4.73 mmol, 0.29 mL) to yield **2.14** as a white solid (0.2386 g, 23%). **(2.14):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.66-7.59 (m, 2H), 7.30-7.23 (m, 2H), 4.53 (s, 2H) 3.46-3.33 (m, 4H), 2.93 (s, 3H), 1.43 (t, 6H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 166.66, 164.18, 136.57, 117.35, 64.97, 57.12, 47.46, 8.65.

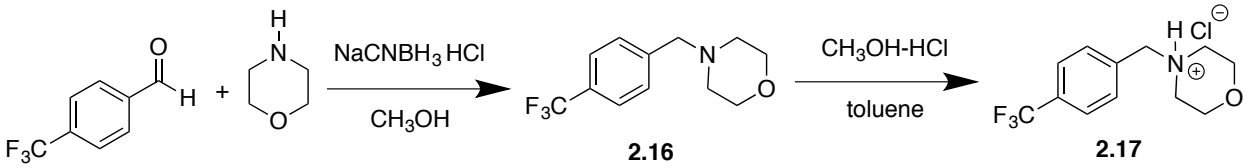


Scheme 2.15: Reductive amination between dimethylamine and 4-fluorobenzaldehyde followed by alkylation.

General Procedure 2.5 was followed. Dimethylamine (2 M, 12.09 mmol, 6 mL) was reacted with 4-fluorobenzaldehyde (1 g, 8.06 mmol, 1.0 mL) and sodium cyanoborohydride (0.5570 g, 8.86 mmol) at 70 °C to yield **2.9** as a light yellow oil. A portion of **2.9** (0.5978 g, 3.93 mmol) was reacted with methyl iodide (1.672 g, 11.78 mmol, 0.73 mL) to yield **2.15** as

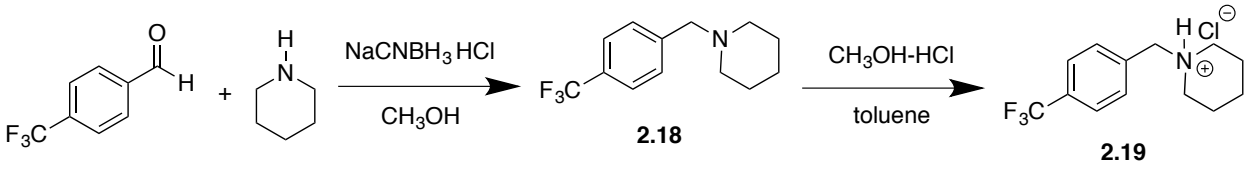
a white solid (0.5412 g, 47%). **(2.15):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.66-7.60 (m, 2H), 7.31-7.25 (m, 2H), 4.57 (s, 2H), 3.12 (s, 9H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 173.80, 171.34, 144.61, 134.14, 125.45, 75.90, 61.07.

2.7 Reaction with 4-(trifluoromethyl)benzaldehyde.



Scheme 2.16: Reductive amination between morpholine and 4-(trifluoromethyl)benzaldehyde followed by protonation.

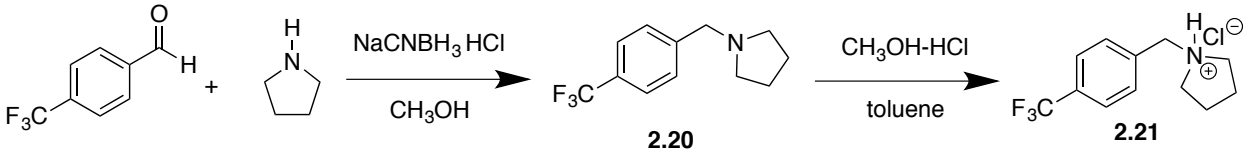
General Procedure 2.4 was followed. Morpholine (0.3753 g, 4.308 mmol, 0.37 mL) was reacted with 4-(trifluoromethyl)benzaldehyde (0.5 g, 2.872 mmol, 0.39 mL) and sodium cyanoborohydride (0.1985 g, 3.16 mmol) to yield **2.16** as a yellow oil. A portion of **2.16** (0.7066 g, 2.881) was protonated to yield **2.17** as a white solid (0.2922 g, 36%). **(2.18):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.89-7.80 (m, 4H), 4.52 (s, 2H), 4.15-3.80 (m, 4H), 3.48-3.21 (m, 4H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 134.11, 133.46, 127.13, 126.62, 123.92, 64.85, 60.98, 53.05.



Scheme 2.17: Reductive amination between piperidine and 4-(trifluoromethyl)benzaldehyde followed by protonation.

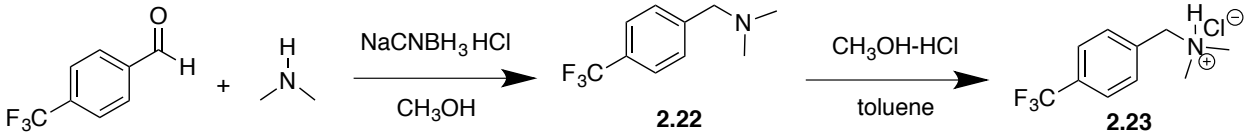
General Procedure 2.4 was followed. Piperidine (0.7336 g, 8.625 mmol, 0.85 mL) was reacted with 4-(trifluoromethyl)benzaldehyde (1.0 g, 5.743 mmol, 0.78 mL) and sodium

cyanoborohydride (0.5570 g, 8.86 mmol) to yield **2.18** as a yellow oil. A portion of **2.18** (0.69 g, 2.47 mmol) was protonated to yield **2.19** as a white solid (0.2632 g, 33%). **(2.19):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.86-7.74 (m, 4H), 4.47 (s, 2H), 3.54-3.26 (d, 2H), 3.081 (t, 2H), 2.025-1.81 (m, 8H), 1.78-1.70 (m, 2H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 134.79, 133.37, 127.07, 60.73, 54.18, 45.74, 24.01, 23.71, 23.05, 22.62. Contaminated with a piperidine-HCl salt.



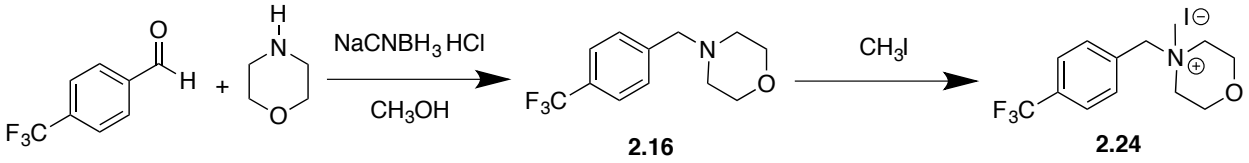
Scheme 2.18: Reductive amination between pyrrolidine and 4-(trifluoromethyl)benzaldehyde followed by protonation.

General Procedure 2.4 was followed. Pyrrolidine (0.6127 g, 8.615 mmol, 0.72 mL) was reacted with 4-(trifluoromethyl)benzaldehyde (1.0 g, 5.743 mmol, 0.78 mL) and sodium cyanoborohydride (0.5570 g, 8.86 mmol) to yield **2.20** as a yellow oil. A portion of **2.20** (0.59 g, 2.574 mmol) was protonated to yield **2.21** as a white solid (0.5375 g, 79%). **(2.21):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.89-7.78 (m, 4H), 4.56 (s, 2H), 3.54-3.34 (m, 4H), 2.15 (s, 4H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 136.48, 132.98, 132.41,127.14, 126.65, 123.95, 58.37, 55.05, 35.41, 23.89.



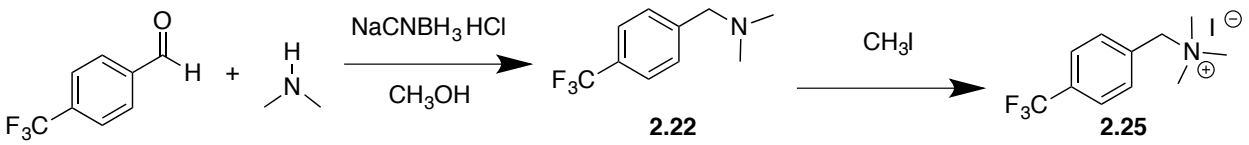
Scheme 2.19: Reductive amination between dimethylamine and 4-(trifluoromethyl)benzaldehyde followed by protonation.

General Procedure 2.4 was followed. Dimethylamine (40% 0.388 g, 8.615 mmol, 0.97 mL) was reacted with 4-(trifluoromethyl)benzaldehyde (1.0 g, 5.743 mmol, 0.78 mL) and sodium cyanoborohydride (0.5570 g, 8.86 mmol) to yield **2.22** as a light yellow oil. A portion of **2.22** (0.97 g, 4.773 mmol) was protonated to yield **2.23** as a white solid (0.1269 g, 11%). **(2.23):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.86-7.75 (m, 4H), 4.45 (s, 2H), 2.90 (s, 6H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 135.43, 133.33, 132.84, 127.30, 126.62, 123.92, 61.34, 43.22.



Scheme 2.20: Reductive amination between morpholine and 4-(trifluoromethyl)benzaldehyde followed by alkylation.

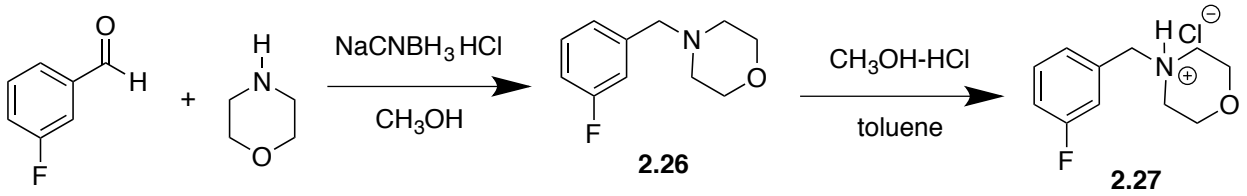
General Procedure 2.5 was followed. Morpholine (0.75 g, 8.615 mmol, 0.75 mL) was reacted with 4-(trifluoromethyl)benzaldehyde (1.0 g, 5.743 mmol, 0.78) and sodium cyanoborohydride (0.397 g, 6.317 mmol) to yield **2.16** as a yellow oil. A portion of **2.16** (0.3631 g, 1.481 mmol) was reacted with methyl iodide (0.684 g, 4.819 mmol, 0.3 mL) to yield **2.24** as a white solid (0.264 g, 69%). **(2.24):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.88 (s, 4H), 4.83 (s, 2H), 4.15-4.00 (m, 4H), 3.55-3.43 (m, 4H), 3.22 (s, 3H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 135.36, 133.80, 133.48, 132.12, 127.16, 123.83, 69.15, 62.52, 61.82, 52.65, 46.69.



Scheme 2.21: Reductive amination between dimethylamine and 4-(trifluoromethyl)benzaldehyde followed by alkylation.

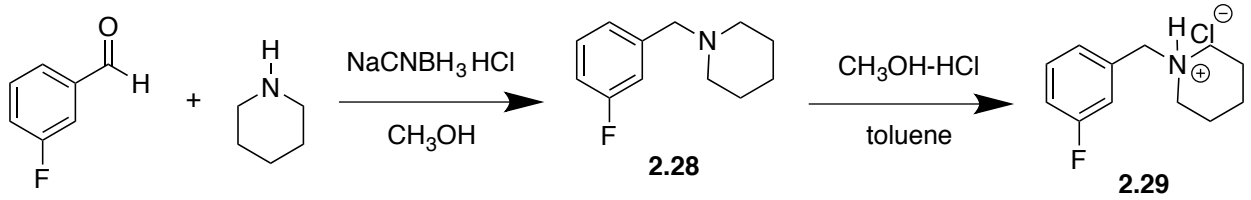
General Procedure 2.5 was followed. Dimethylamine (40%, 0.388 g, 8.615 mmol, 0.97 mL) was reacted with 4-(trifluoromethyl)benzaldehyde (1.0 g, 5.743 mmol, 0.78 mL) and sodium cyanoborohydride (0.397 g, 6.317 mmol) at 70 °C to yield **2.22** as a light yellow oil. A portion of **2.22** (0.473 g, 2.32 mmol) was reacted with methyl iodide (0.9911 g, 6.98 mmol, 0.43 mL) to yield **2.25** as a white solid (0.2986 g, 37%). **(2.25):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.95-7.90 (m, 4H), 4.82 (s, 2H), 3.28 (s, 9H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 134.99, 133.83, 133.51, 133.29, 127.15, 123.87, 69.24, 53.56, 30.74.

2.8 Reaction with 3-fluorobelzaldehyde.



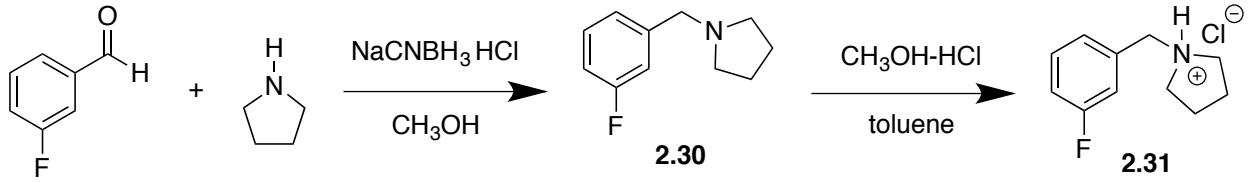
Scheme 2.22: Reductive amination between morpholine and 3-fluorobenzaldehyde followed by protonation.

General Procedure 2.4 was followed. Morpholine (1.05 g, 12.09 mmol, 1.04 mL) reacted with 3-fluorobenzaldehyde (1.0 g, 8.057 mmol, 0.85 mL) and sodium cyanoborohydride (0.557 g, 8.86 mmol) to yield **2.26** as a light brown oil. A portion of **2.26** (0.67 g, 3.432 mmol) was protonated to yield **2.27** as a white solid (0.3878 g, 49%). **(2.27):** ^{1}H NMR (400 MHz, DMSO, δ_H) 7.60-7.48 (m, 3H), 7.34-7.26 (m, 1H), 4.47 (s, 2H), 4.03-3.92 (m, 5H), 3.40-3.32 (m, 4H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 163.58, 161.15, 131.22, 118.62, 116.70, 63.45, 58.51, 43.00, 31.13.



Scheme 2.23: Reductive amination between piperidine and 3-fluorobenzaldehyde followed by protonation.

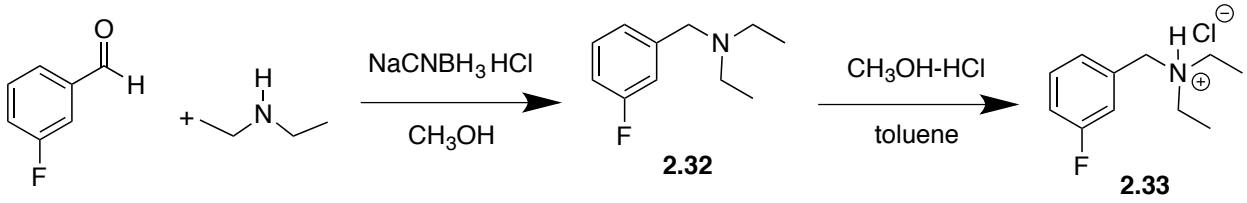
General Procedure 2.4 was followed. Piperidine (1.03 g, 12.09 mmol, 1.2 mL) reacted with 3-fluorobenzaldehyde (1.0 g, 8.057 mmol, 0.85 mL) and sodium cyanoborohydride (0.557 g, 8.86 mmol) to yield **2.28** as a dark yellow oil. A portion of **2.28** (0.68 g, 3.518 mmol) was protonated to yield **2.29** as a white solid (0.2417 g, 30%). **(2.29):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.56-7.49 (m, 1H), 7.47-7.41 (m, 2H), 7.29-7.22 (m, 1H), 4.36 (s, 2H), 3.50-2.96 (m, 4H), 1.99-1.89 (m, 2H), 1.76-1.67 (m, 2H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 165.45, 163.00, 132.94, 132.21, 128.50, 119.38, 119.16, 118.04, 117.83, 60.79, 54.04, 24.00, 23.68, 23.05, 22.67.



Scheme 2.24: Reductive amination between pyrrolidine and 3-fluorobenzaldehyde followed by protonation.

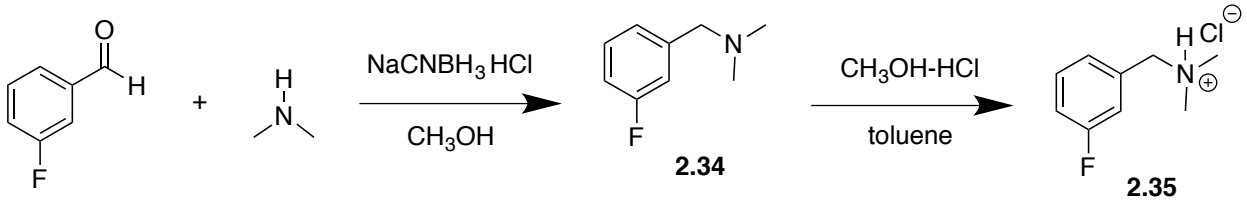
General Procedure 2.4 was followed. Pyrrolidine (0.8598 g, 12.09 mmol, 0.852 mL) reacted with 3-fluorobenzaldehyde (1.0 g, 8.057 mmol, 0.85 mL) and sodium cyanoborohydride (0.557 g, 8.86 mmol). An additional portion of pyrrolidine (0.8598 g, 12.09 mmol, 0.852 mL), hydrochloric acid (0.35 mL), and sodium cyanoborohydride (0.557, 8.86 mmol) and reacted for 2 h at 80 °C to yield **2.30** as a dark yellow oil. A portion

of **2.30** (1.444 g, 8.06 mmol) was protonated to yield **2.31** as a white solid (1.0016 g, 58%). **(2.31):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.48-7.35 (m, 3H), 7.19-7.11 (m, 1H), 4.38 (s, 2H), 3.36-3.26 (m, 4H), 2.11-1.99 (m, 4H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 165.44, 163.00, 134.78, 132.26, 127.50, 118.46, 118.24, 117.77, 117.56, 58.42, 54.86, 52.49, 46.55, 25.02, 23.88, 19.14.



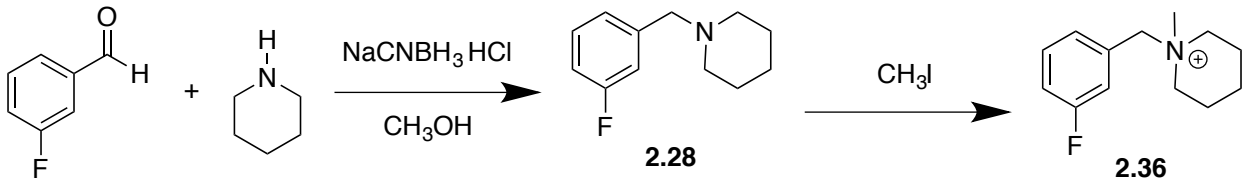
Scheme 2.25: Reductive amination between diethylamine and 3-fluorobenzaldehyde followed by protonation.

General Procedure 2.4 was followed. Diethylamine (0.884, 12.09 mmol, 1.25 mL) reacted with 3-fluorobenzaldehyde (1.0 g, 8.057 mmol, 0.85 mL) and sodium cyanoborohydride (0.557 g, 8.86 mmol) to yield **2.32** as a dark yellow oil. A portion of **2.32** (0.62 g, 3.421 mmol) was protonated to yield **2.33** as a white solid (0.4013 g, 54%). **(2.33):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.61-7.53 (m, 1H), 7.51-7.46 (m, 2H), 7.32-7.25 (m, 1H), 4.44 (s, 2H), 3.38-3.20 (m, 4H), 1.46-1.38 (m, 6H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 165.51, 163.06, 133.44, 132.28, 128.09, 118.80, 118.01, 56.55, 43.52, 11.55, 9.07.



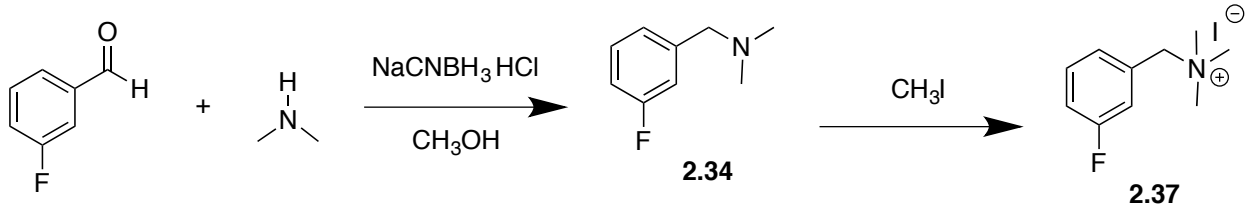
Scheme 2.26: Reductive amination between dimethylamine and 3-fluorobenzaldehyde followed by protonation.

General Procedure 2.4 was followed. Dimethylamine (2M, 12.09 mmol, 6 mL) reacted with 3-fluorobenzaldehyde (1.0 g, 8.057 mmol, 0.85 mL) and sodium cyanoborohydride (0.557 g, 8.86 mmol) to yield **2.34** as a yellow oil. A portion of **2.34** (0.47 g, 3.068 mmol) was protonated to yield **2.35** as a white solid (0.3187 g, 55%). **(2.35):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.60-7.53 (m, 1H), 7.48-7.43 (m, 2H), 7.32-7.25 (m, 1H), 4.44 (s, 2H), 2.93 (s, 6H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 165.47, 163.02, 133.50, 132.37, 128.06, 118.98, 118.75, 118.15, 117.94, 61.27, 43.08.



Scheme 2.27: Reductive amination between piperidine and 3-fluorobenzaldehyde followed by alkylation.

General Procedure 2.5 was followed. Piperidine (1.029 g, 12.09 mmol, 1.2 mL) reacted with 3-fluorobenzaldehyde (1.0 g, 8.0573 mmol, 0.85 mL) and sodium cyanoborohydride (0.557 g, 8.863 mmol) to yield **2.28** as a dark yellow oil. A portion of **2.28** (0.8707 g, 4.5 mmol) was reacted with methyl iodide (0.959 g, 6.76 mmol, 0.42 mL) to yield **2.36** as a white solid (0.4496 g, 31%). **(2.36):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.62-7.55 (m, 1H), 7.53-7.47 (m, 2H), 7.38-7.31 (m, 1H), 4.65 (s, 2H), 3,178 (s, 10H), 3.06 (s, 3H), 2.06-1.91 (m, 1.77-1.67 (m, 4H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 165.22, 162.77, 132.21, 130.85, 121.16, 120.94, 118.80, 118.59, 68.06, 64.01, 62.09, 52.59, 21.99, 21.76, 21.28, 21.07. Contaminated with a piperidine-CH_3I salt.



Scheme 2.28: Reductive amination between dimethylamine and 3-fluorobenzaldehyde followed by alkylation.

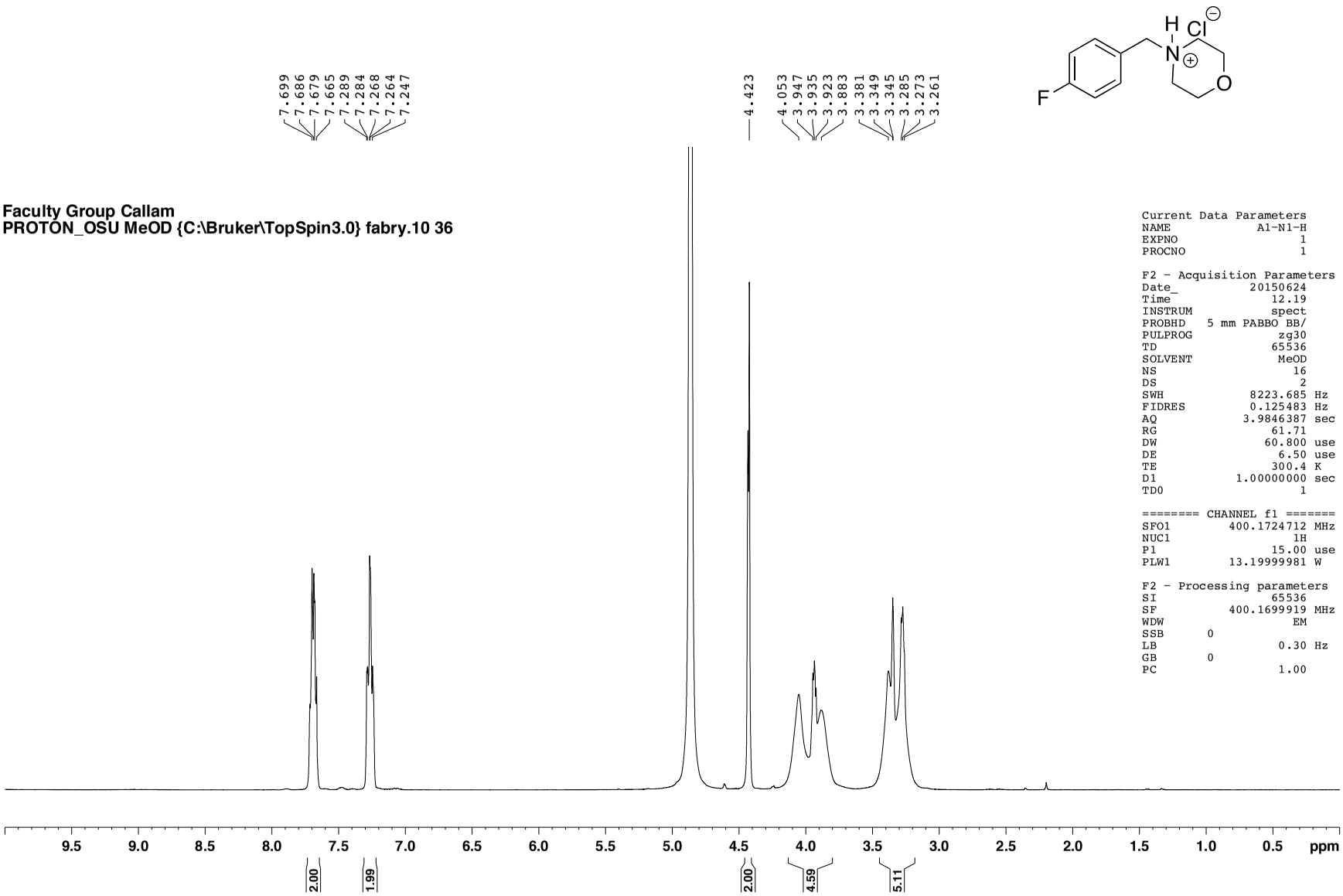
General Procedure 2.5 was followed. Dimethylamine (2M, 12.09 mmol, 6 mL) reacted with 3-fluorobenzaldehyde (1.0 g, 8.057 mmol, 0.85 mL) and sodium cyanoborohydride (0.557 g, 8.86 mmol) to yield **2.34** as a yellow oil. A portion of **2.34** (0.4485 g, 2.93 mmol) was reacted with methyl iodide (0.623 g, 4.39 mmol, 0.27 mL) to yield **2.37** as a white solid (0.3434 g, 40%). **(2.37):** ^{1}H NMR (400 MHz, CD_3OD, δ_H) 7.63-7.56 (m, 1H), 7.51-7.44 (m, 2H), 7.39-7.32 (m, 1H), 4.70 (s, 2H), 3.22 (s, 9H); ^{13}C NMR (100.6 MHz, CD_3OD, δ_C) 165.34, 162.88, 132.33, 131.41, 130.15, 120.92, 120.70, 118.99, 118.78, 69.46, 53.54.

References:

1. Ellman, G.; Courtney, K.; Andres, V.; Featherstone, R. *Biochemical Pharmacology*, **1961**, 7, 88-95.

Appendix A

^{1}H NMR and ^{13}C NMR Spectra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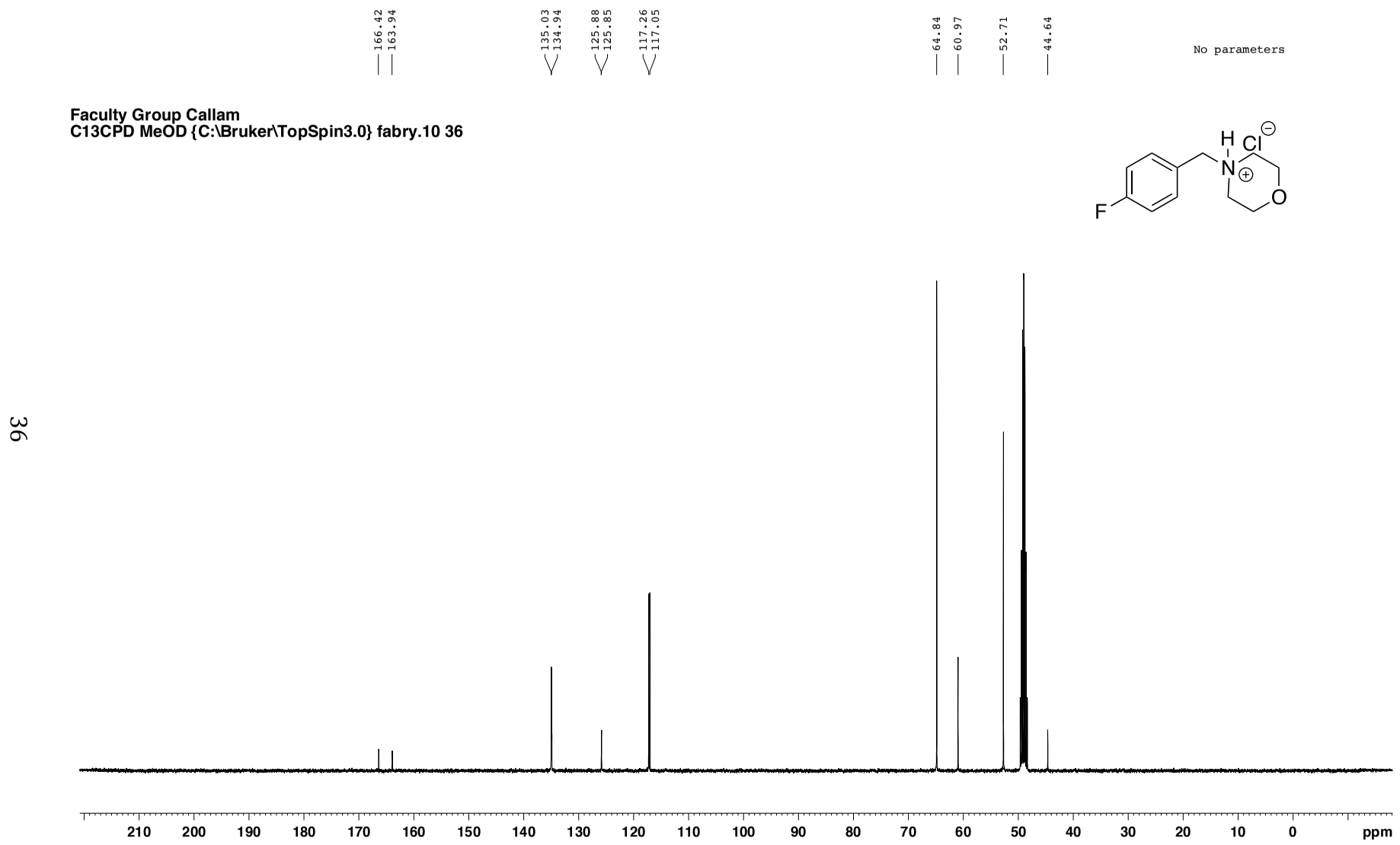
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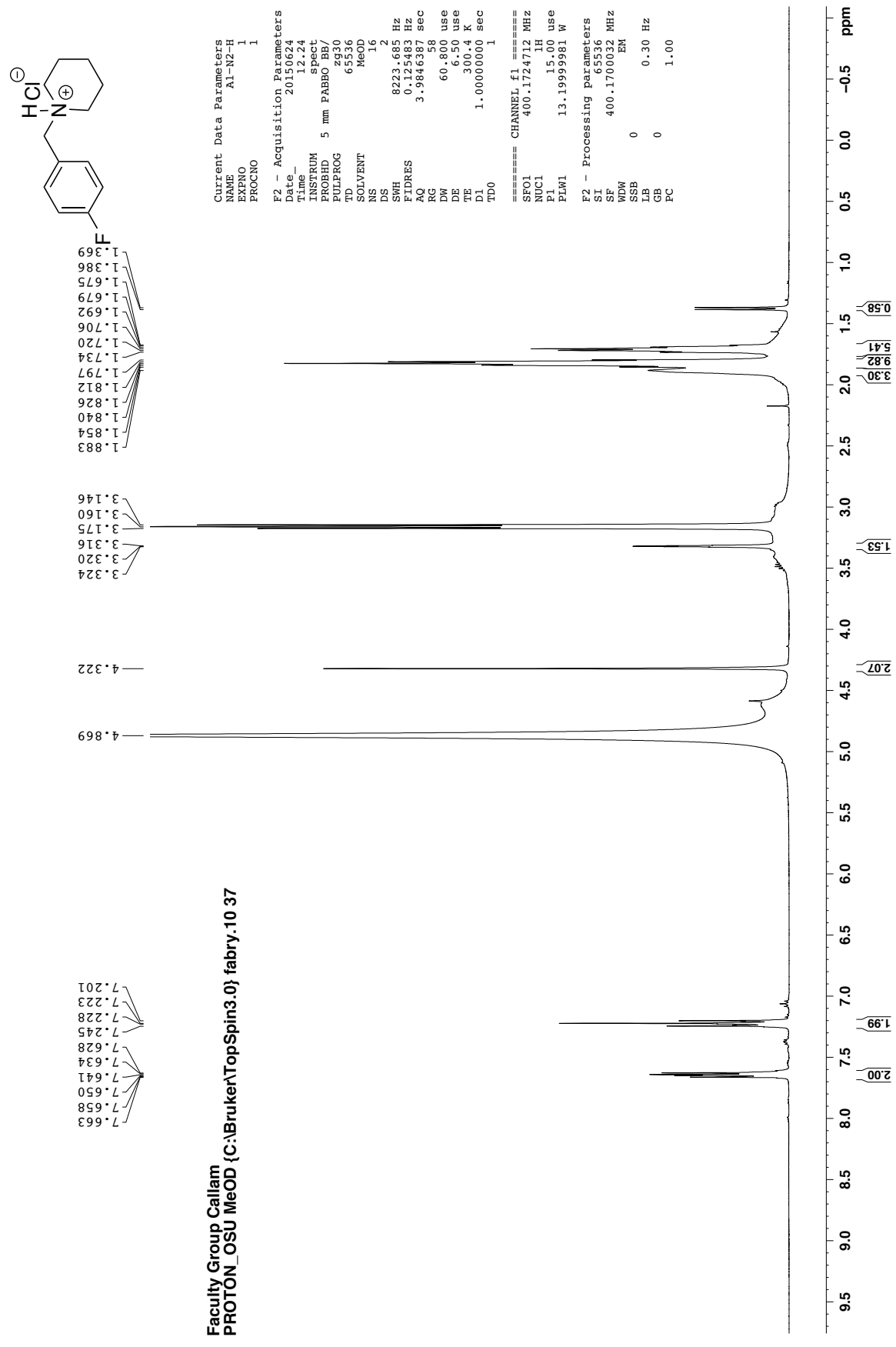
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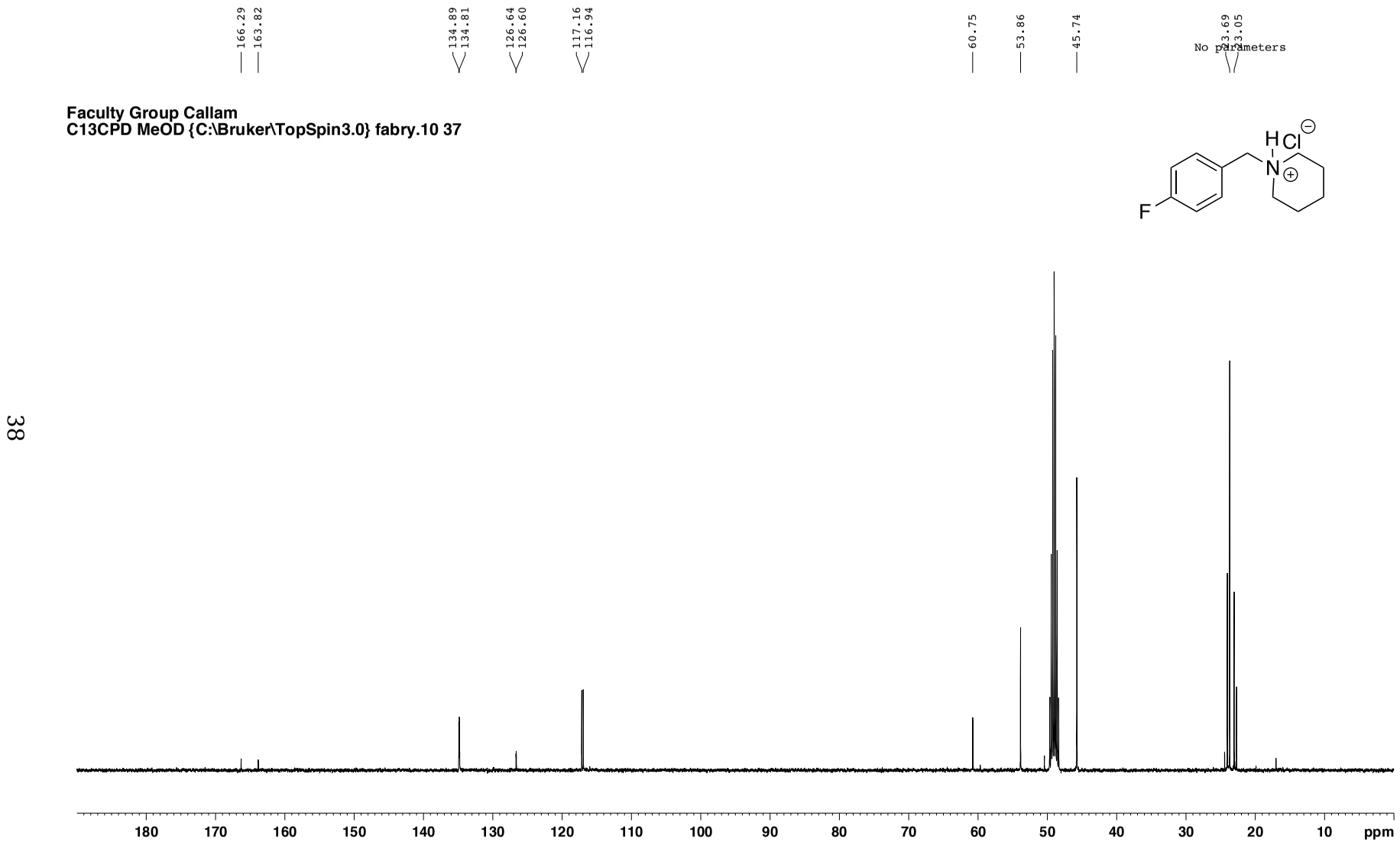
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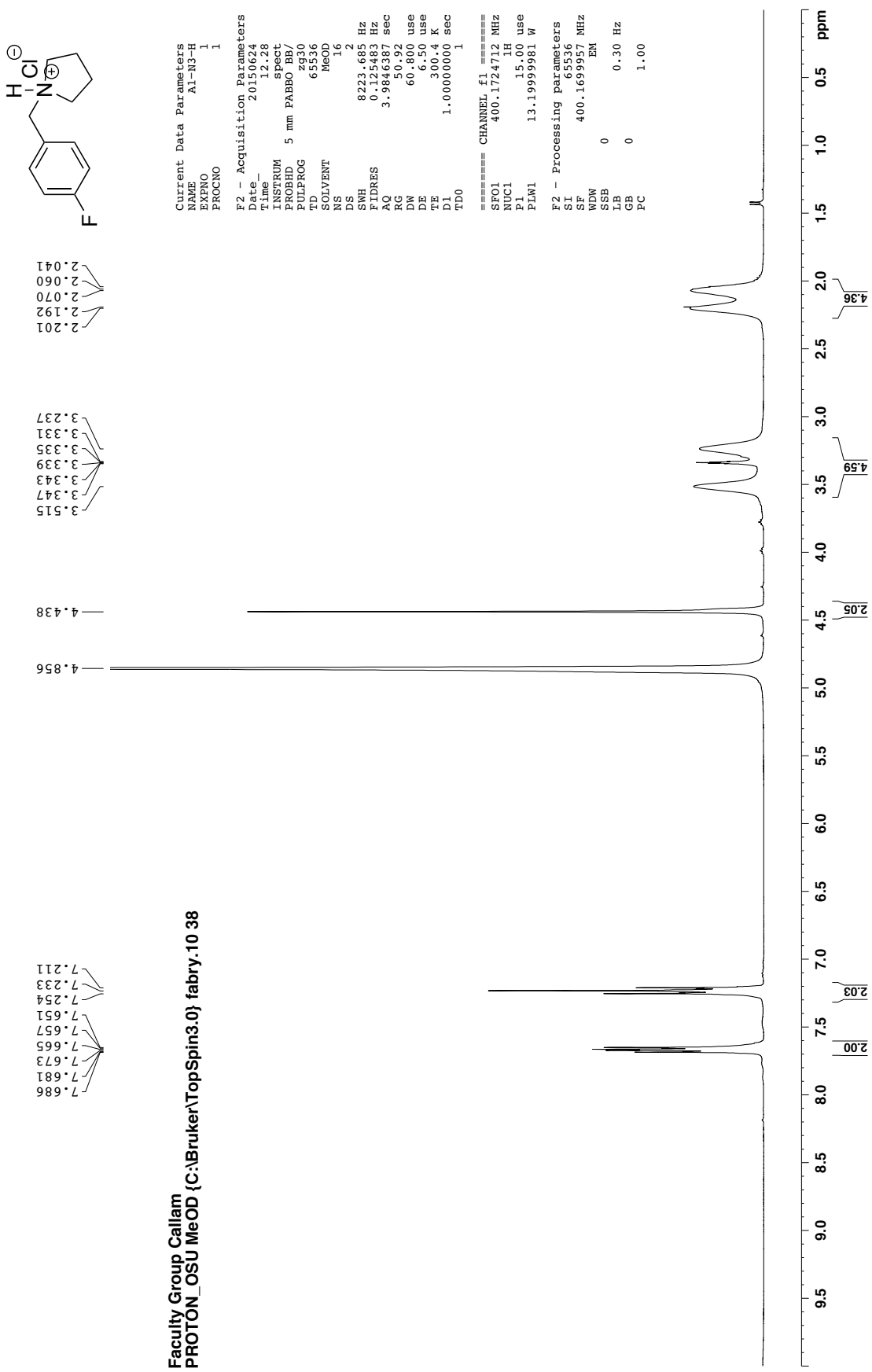
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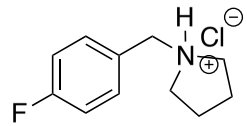

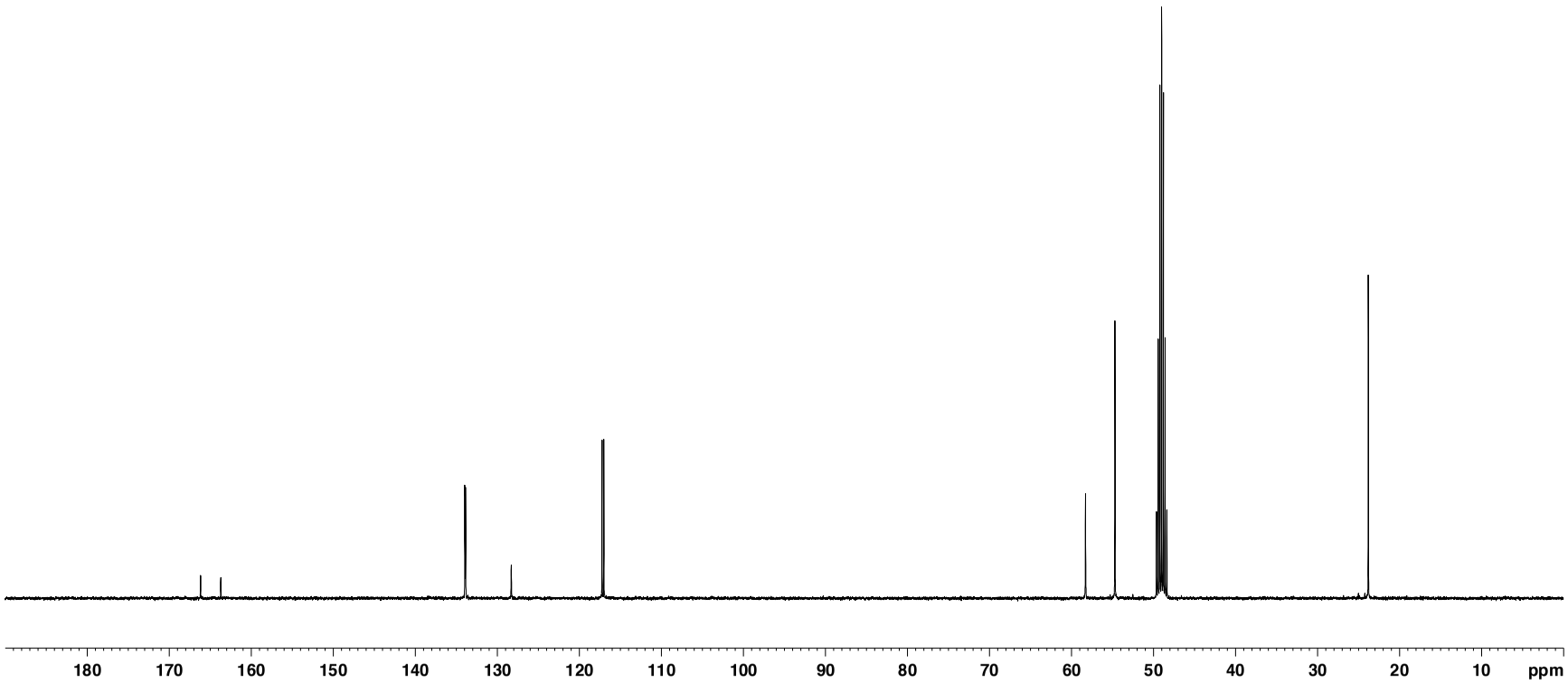

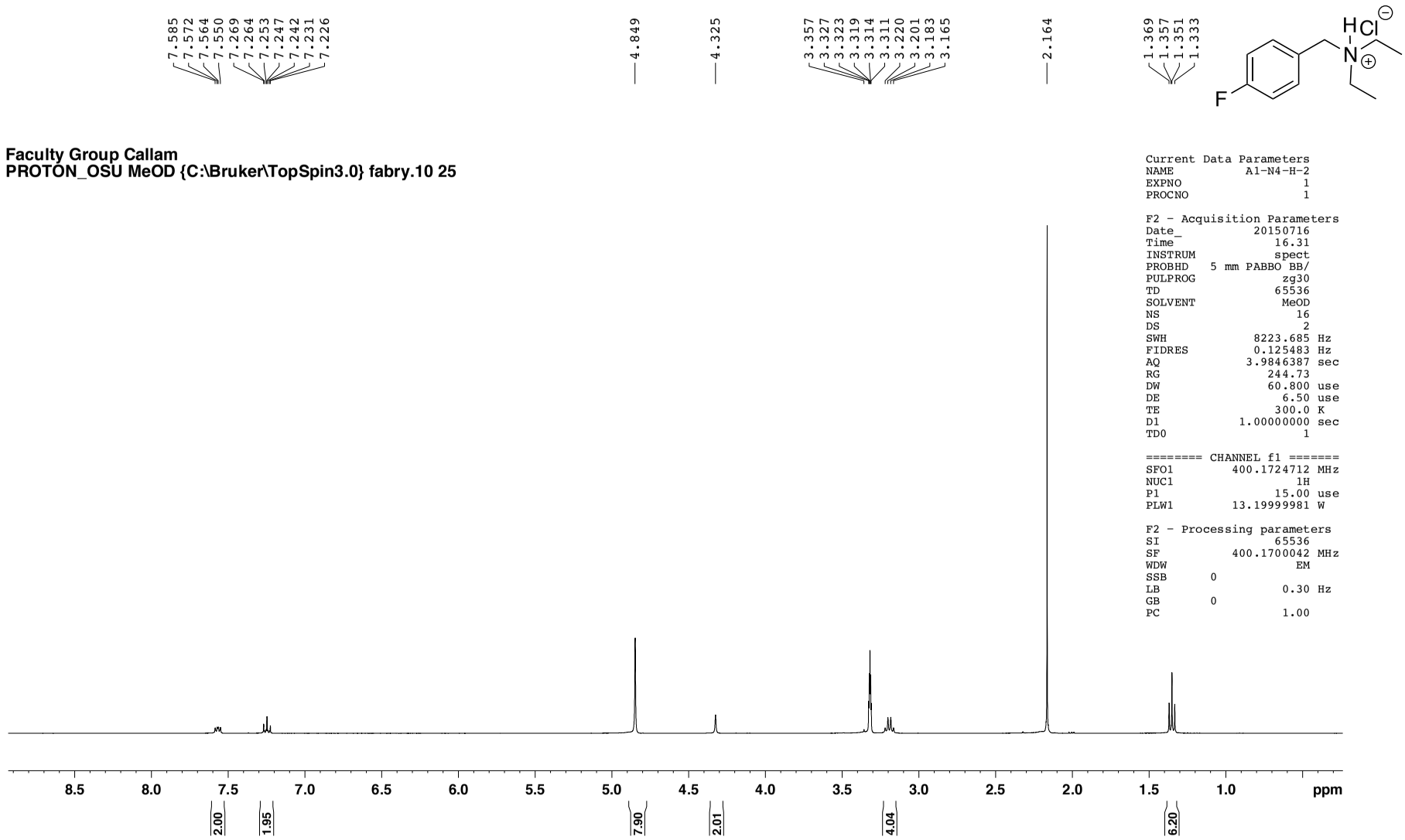
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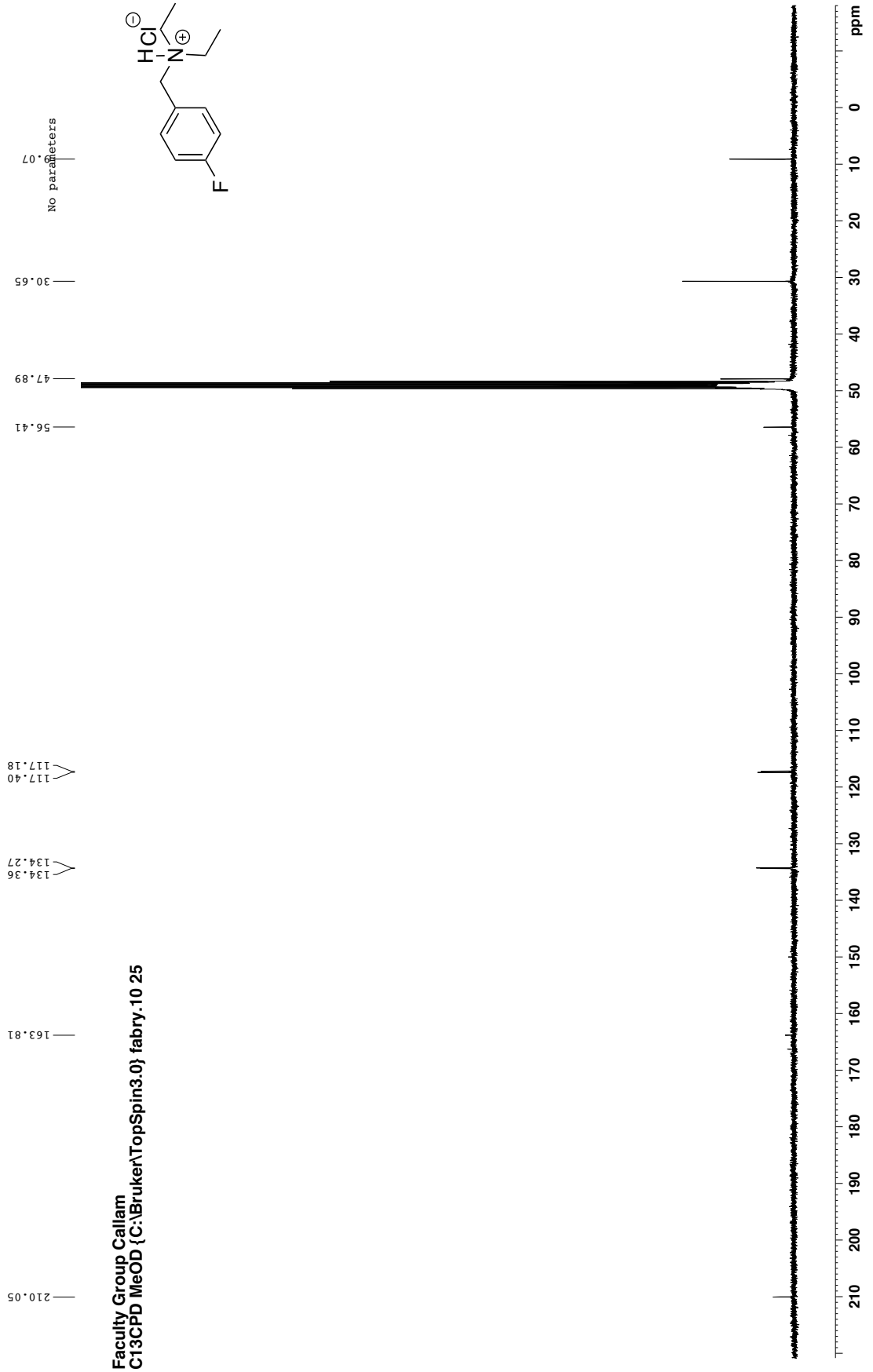
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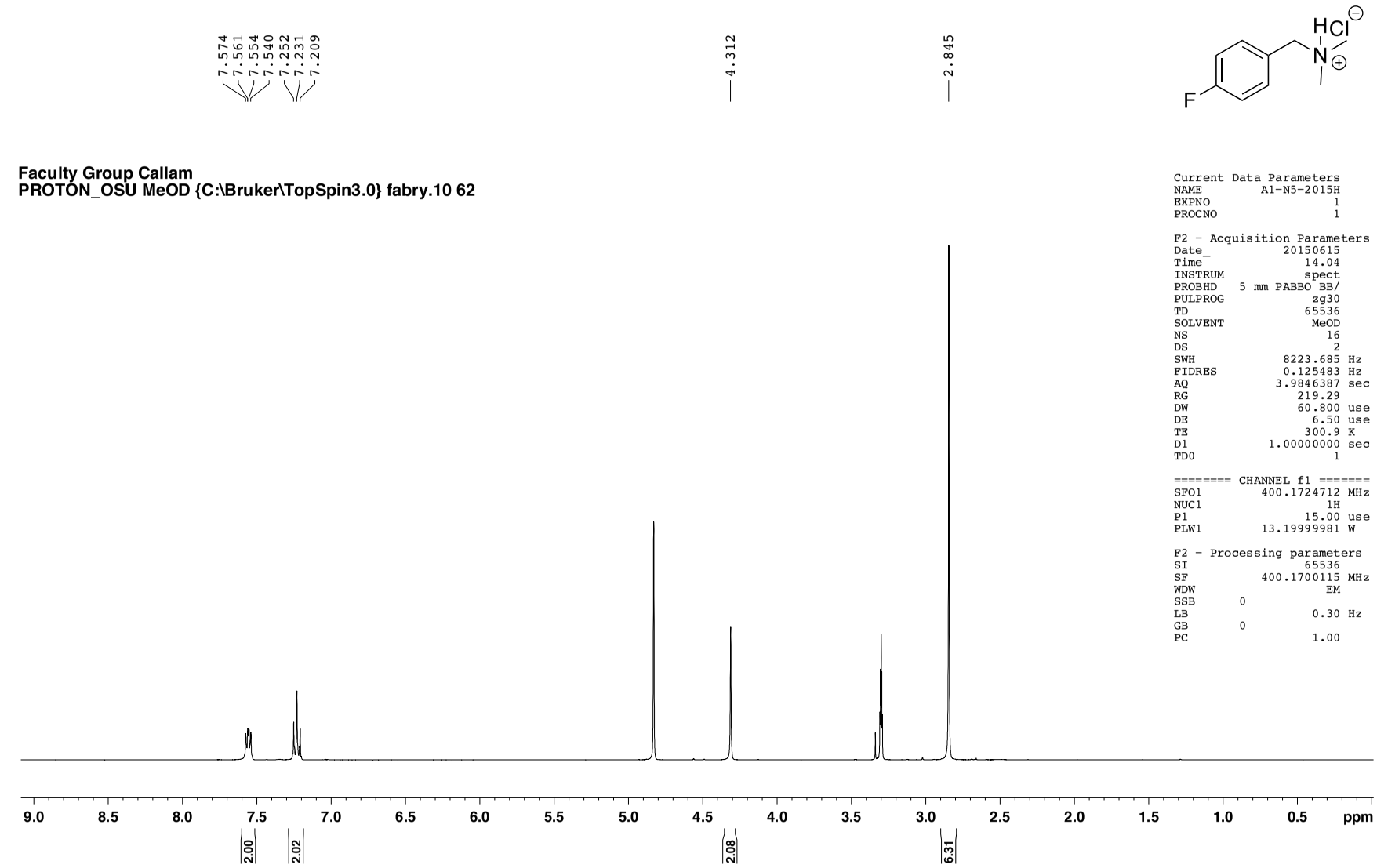
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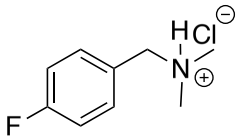
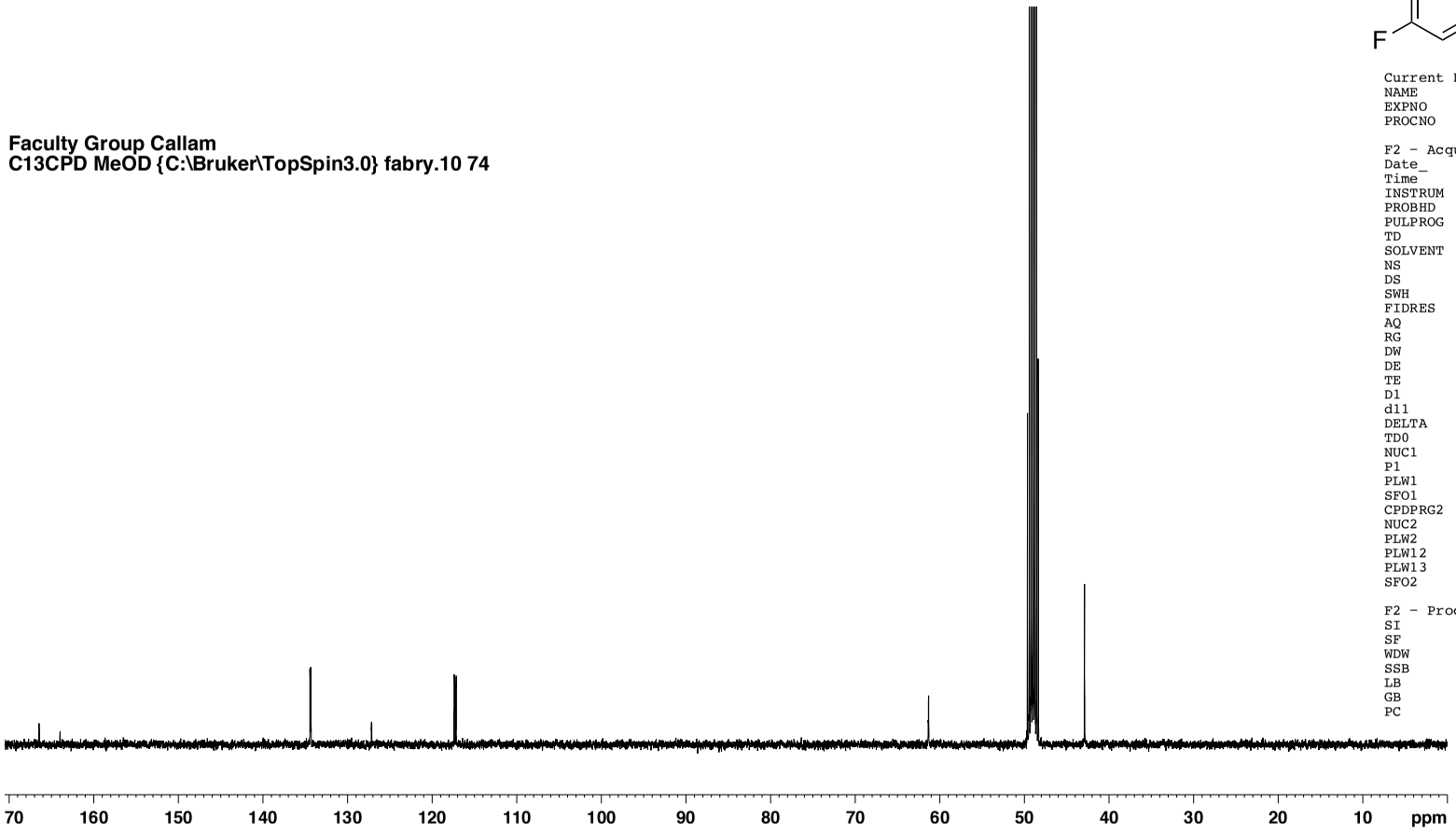
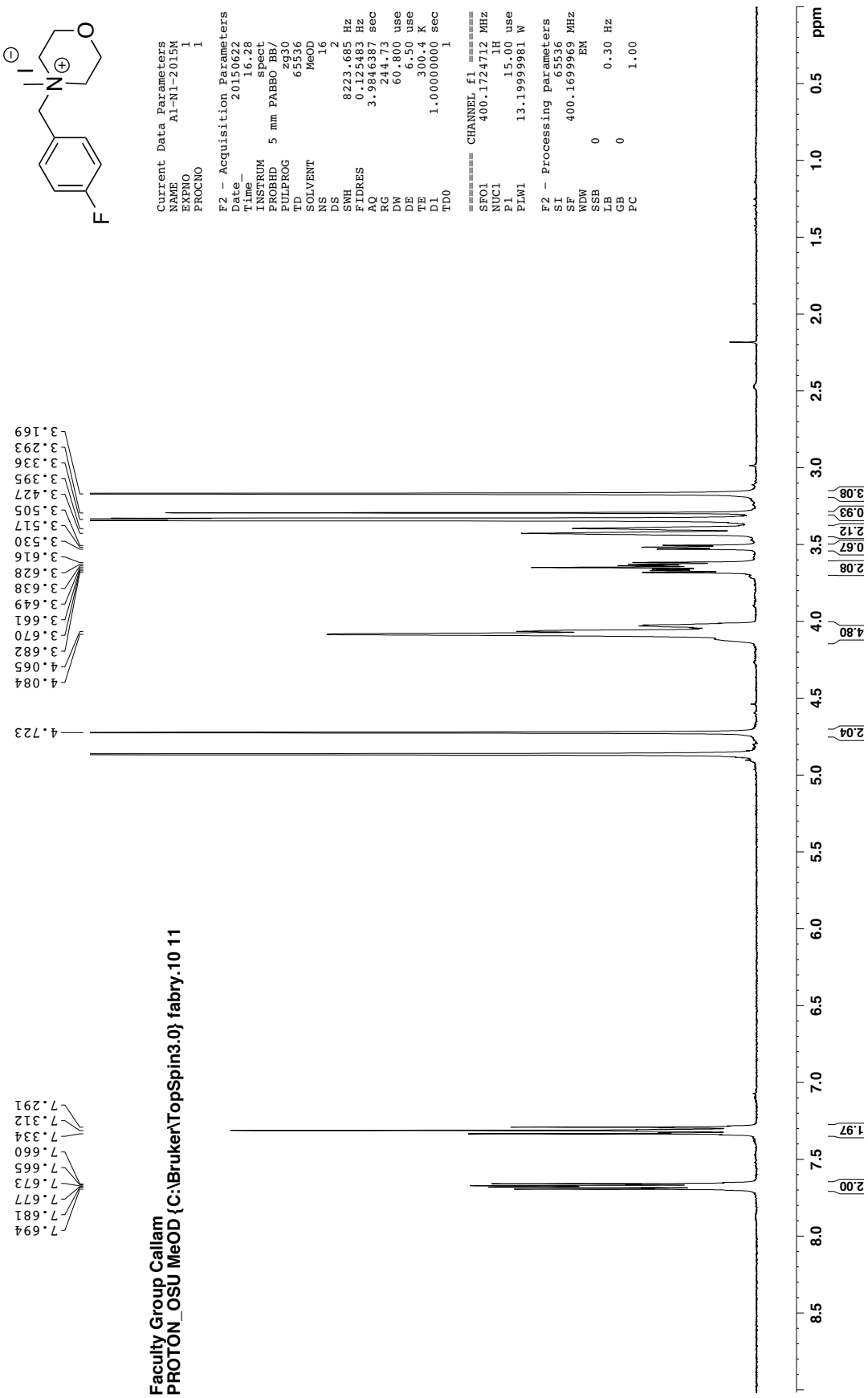
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1700115 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
2.02
2.08
6.31

Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 74





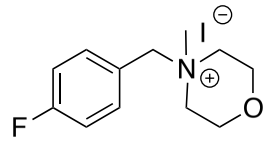

```
Current Data Parameters
NAME          A1-N5-2015H
EXPNO                   2
PROCNO                  1

F2 - Acquisition Parameters
Date_            20150616
Time                5.08
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 65536
SOLVENT              MeOD
NS                   1024
DS                      4
SWH            24038.461 Hz
FIDRES          0.366798 Hz
AQ             1.3631988 sec
RG                   2050
DW                20.800 use
DE                 6.50 use
TE                303.1 K
D1             2.00000000 sec
d11            0.03000000 sec
DELTA          1.89999998 sec
TD0                     1
NUC1                  13C
P1                 9.50 use
PLW1          53.29999924 W
SFO1         100.6328883 MHz
CPDPRG2
NUC2                  1H
PLW2          14.60000038 W
PLW12          0.51327997 W
PLW13          0.32850000 W
SFO2         400.1716007 MHz

F2 - Processing parameters
SI                  32768
SF           100.6226851 MHz
WDW                    EM
SSB       0
LB                  1.00 Hz
GB        0
PC                  1.40
```

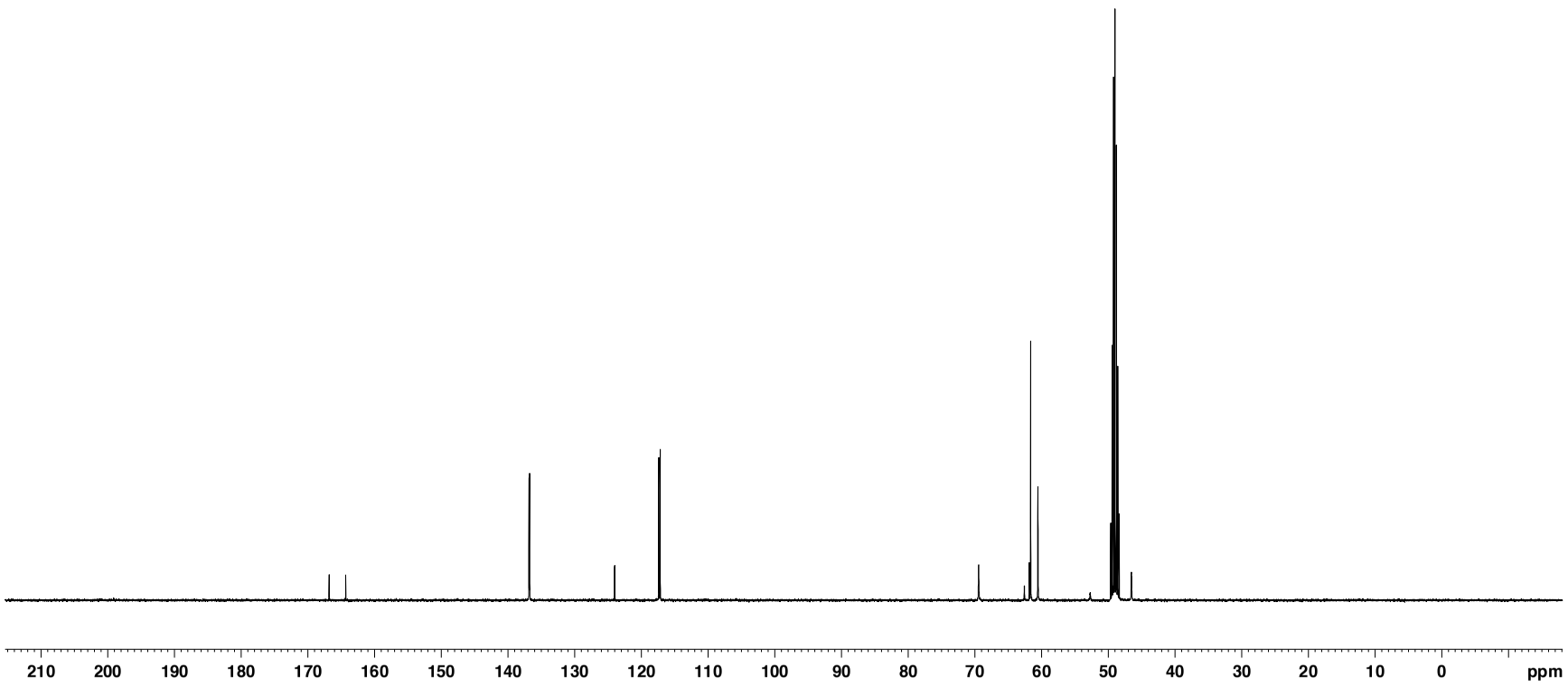

Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 11
Current Data Parameters
NAME A1-N1-2015M
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150622
Time 16.28
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 244.73
DW 60.800 use
DE 6.50 use
TE 300.4 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1699969 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
7.694
7.681
7.677
7.673
7.665
7.660
7.334
7.312
7.291
4.723
4.084
4.065
3.682
3.670
3.661
3.649
3.638
3.628
3.616
3.530
3.517
3.505
3.427
3.395
3.336
3.293
3.169
2.00
1.97
2.04
4.80
2.08
0.67
2.12
0.93
3.08
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

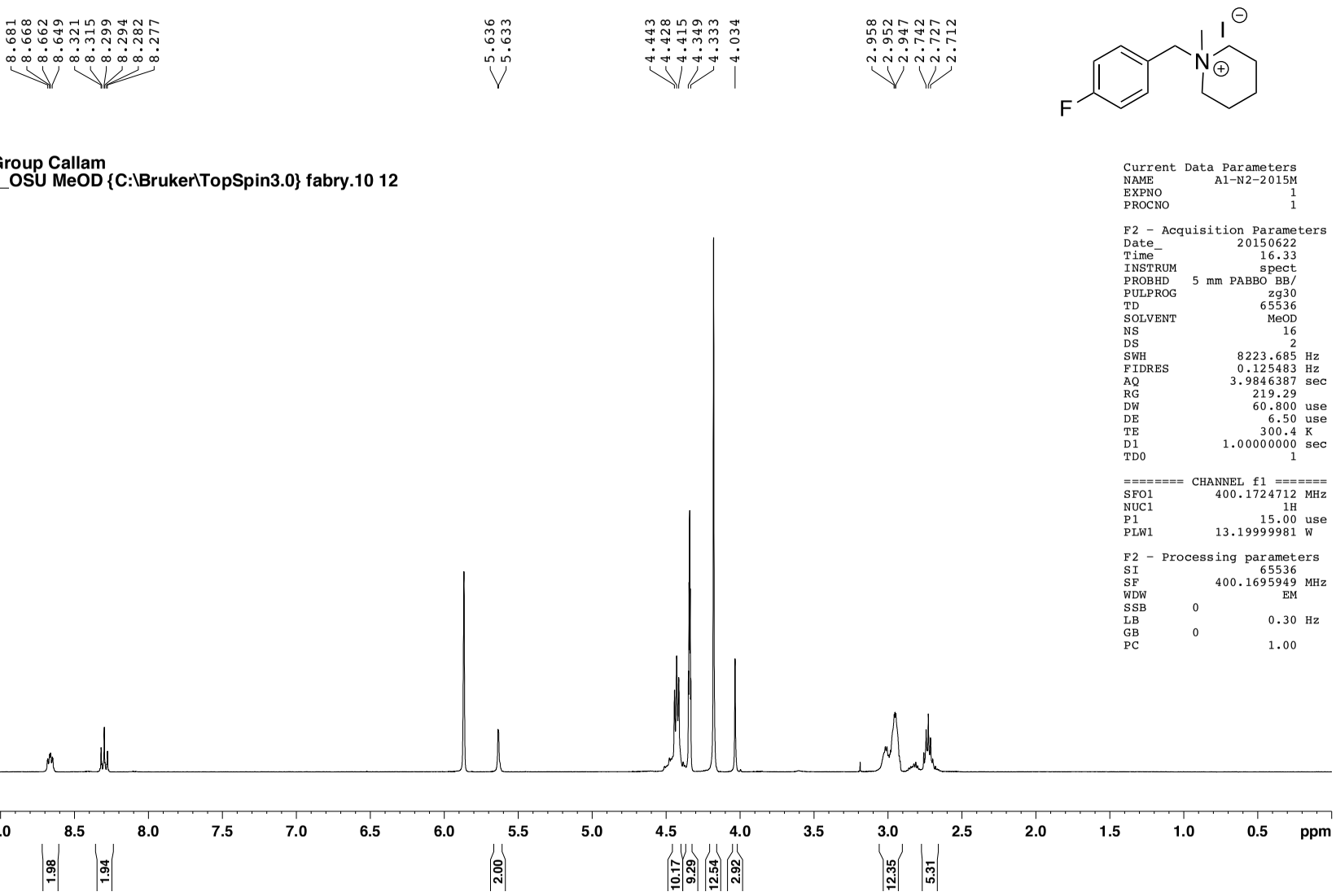
166.83
164.34
136.86
136.78
124.04
124.01
117.40
117.18
69.44
61.64
60.55
52.72
46.53

No parameters

Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 4

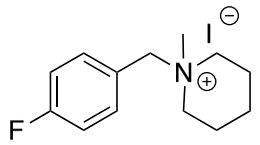


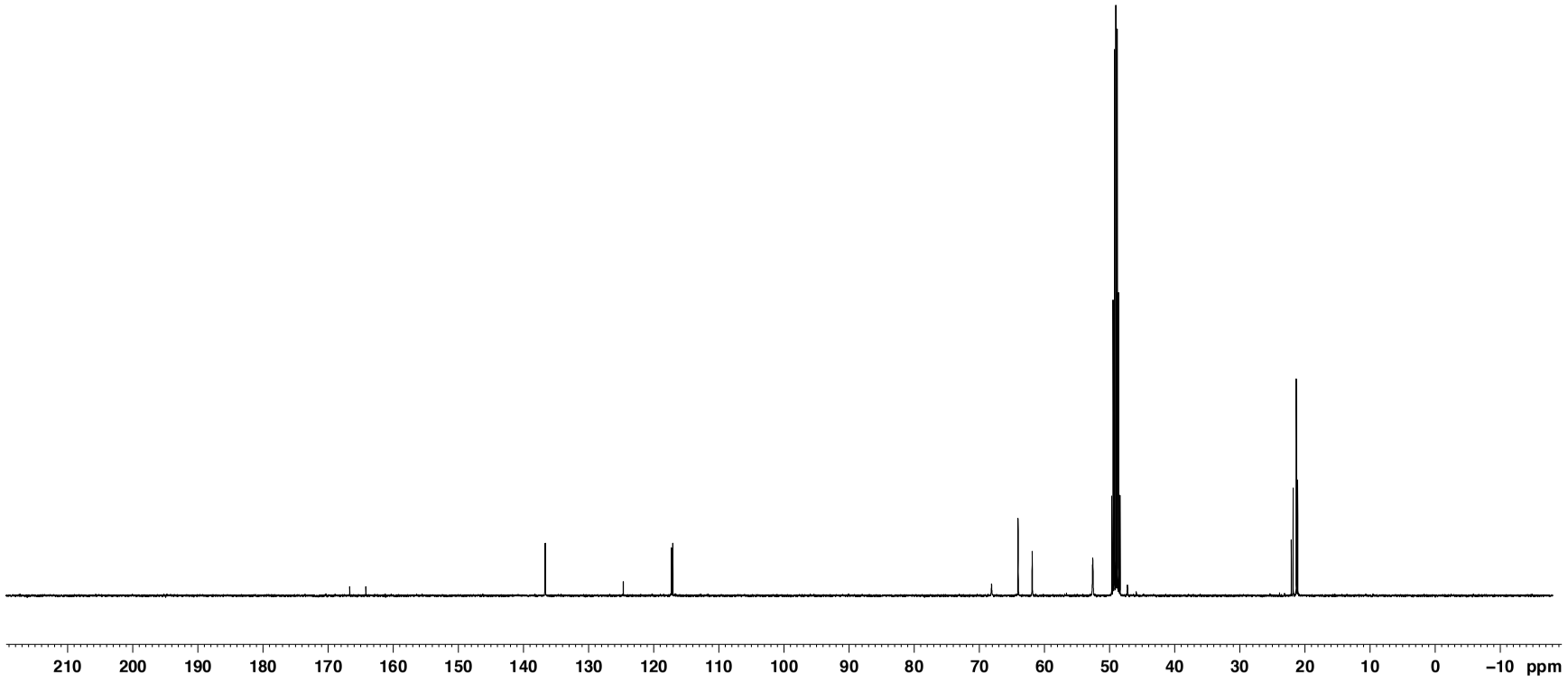


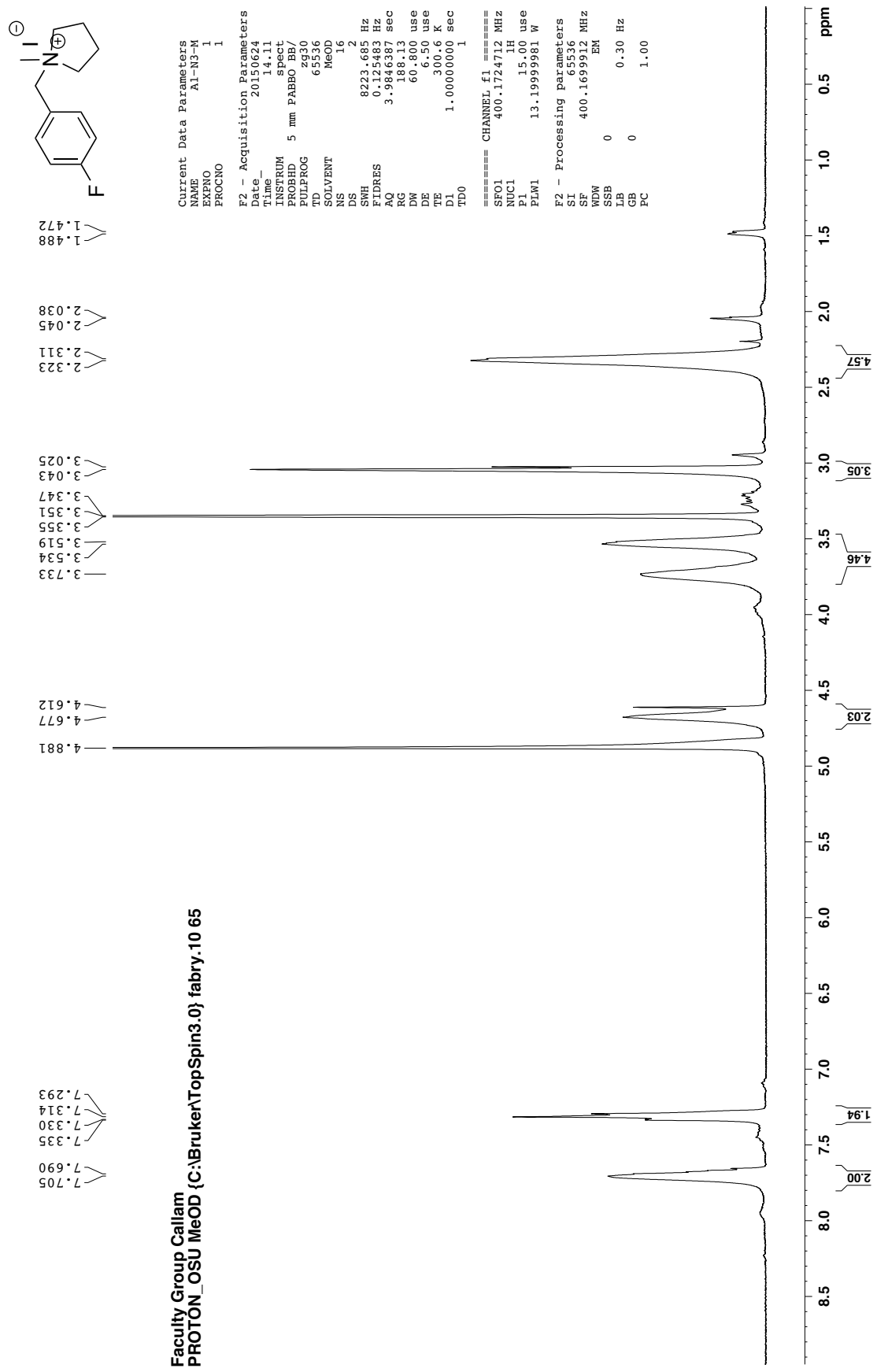

8.681
8.668
8.662
8.649
8.321
8.315
8.299
8.294
8.282
8.277
5.636
5.633
4.443
4.428
4.415
4.349
4.333
4.034
2.958
2.952
2.947
2.742
2.727
2.712
F
I
N
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 12
Current Data Parameters
NAME A1-N2-2015M
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150622
Time 16.33
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 219.29
DW 60.800 use
DE 6.50 use
TE 300.4 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1695949 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.98
1.94
2.00
10.17
9.29
12.54
2.92
12.35
5.31

166.70
164.22
136.71
136.62
124.69
124.65
117.27
117.05
68.11
64.06
64.03
64.01
61.86
52.56
47.23
21.28
No parameters

Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 5

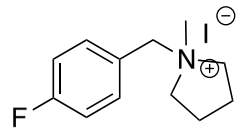


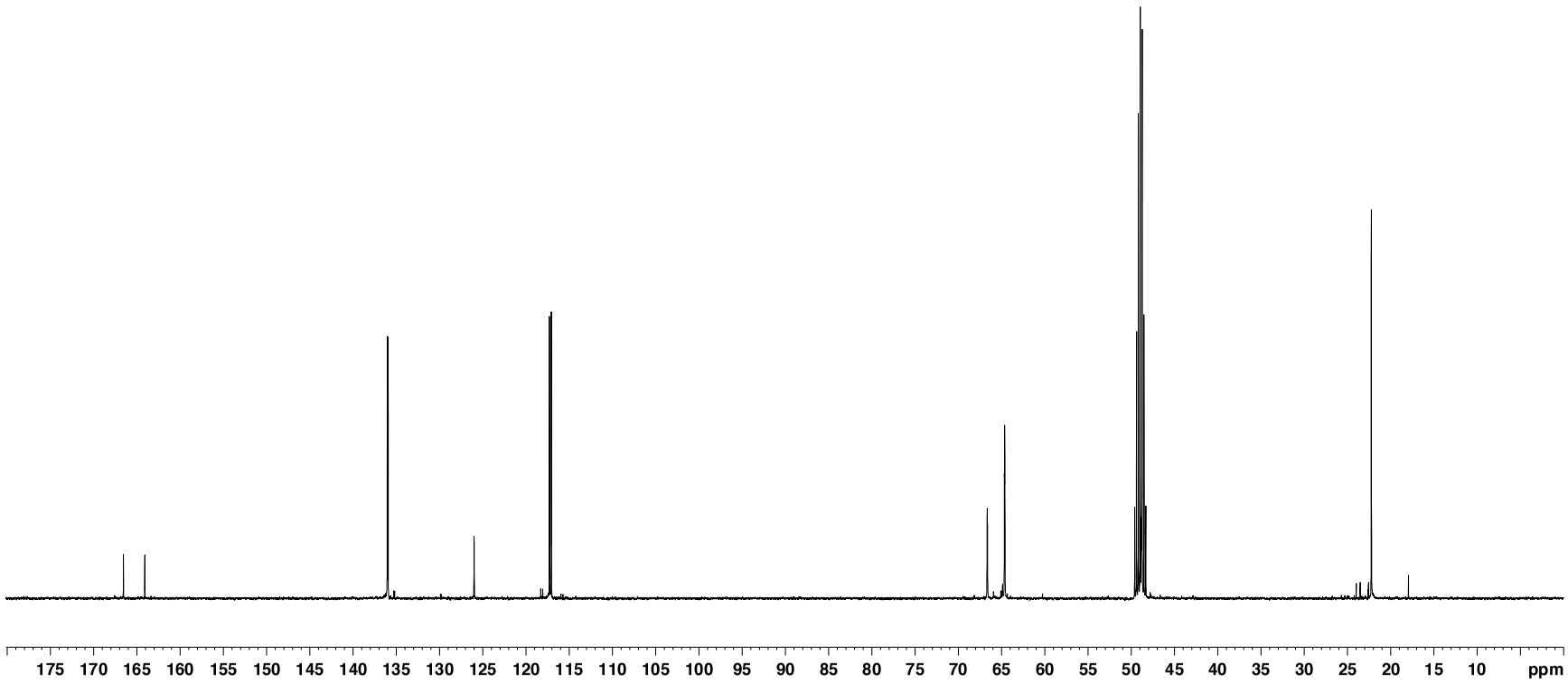


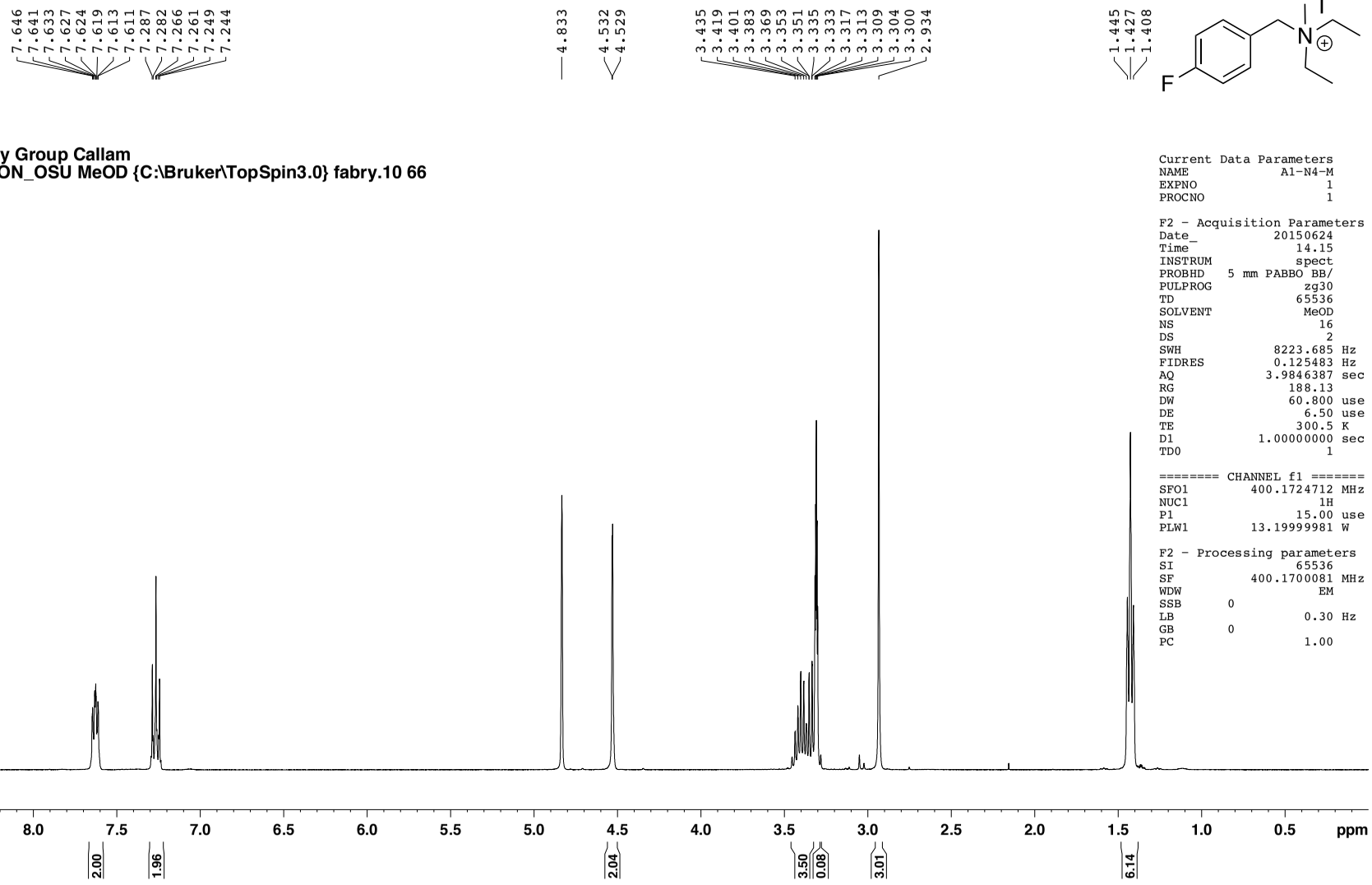

Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 65
Current Data Parameters
NAME A1-N3-M
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150624
Time 14.11
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125403 Hz
AQ 3.9846387 sec
RG 188.13
DW 60.800 use
DE 6.50 use
TE 300.6 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1699912 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
7.705
7.690
7.335
7.330
7.314
7.293
4.881
4.677
4.612
3.733
3.534
3.519
3.355
3.351
3.347
3.043
3.025
2.323
2.311
2.045
2.038
1.488
1.472
2.00
1.94
2.03
4.46
3.05
4.57
ppm

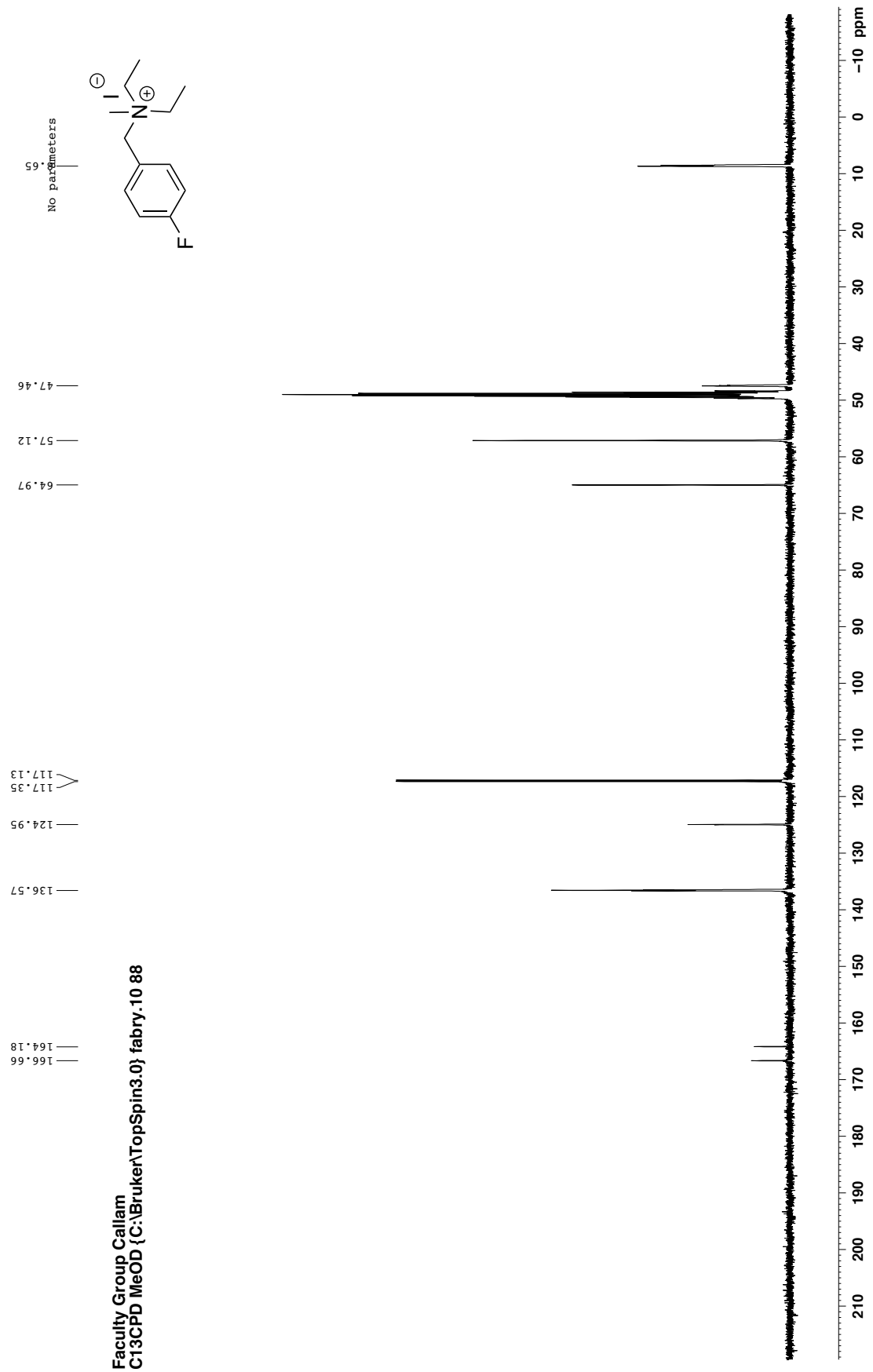
166.58
164.10
136.06
135.97
126.03
126.00
117.31
117.09
66.68
64.69
64.66
64.63
No parameters
2.26
7.96

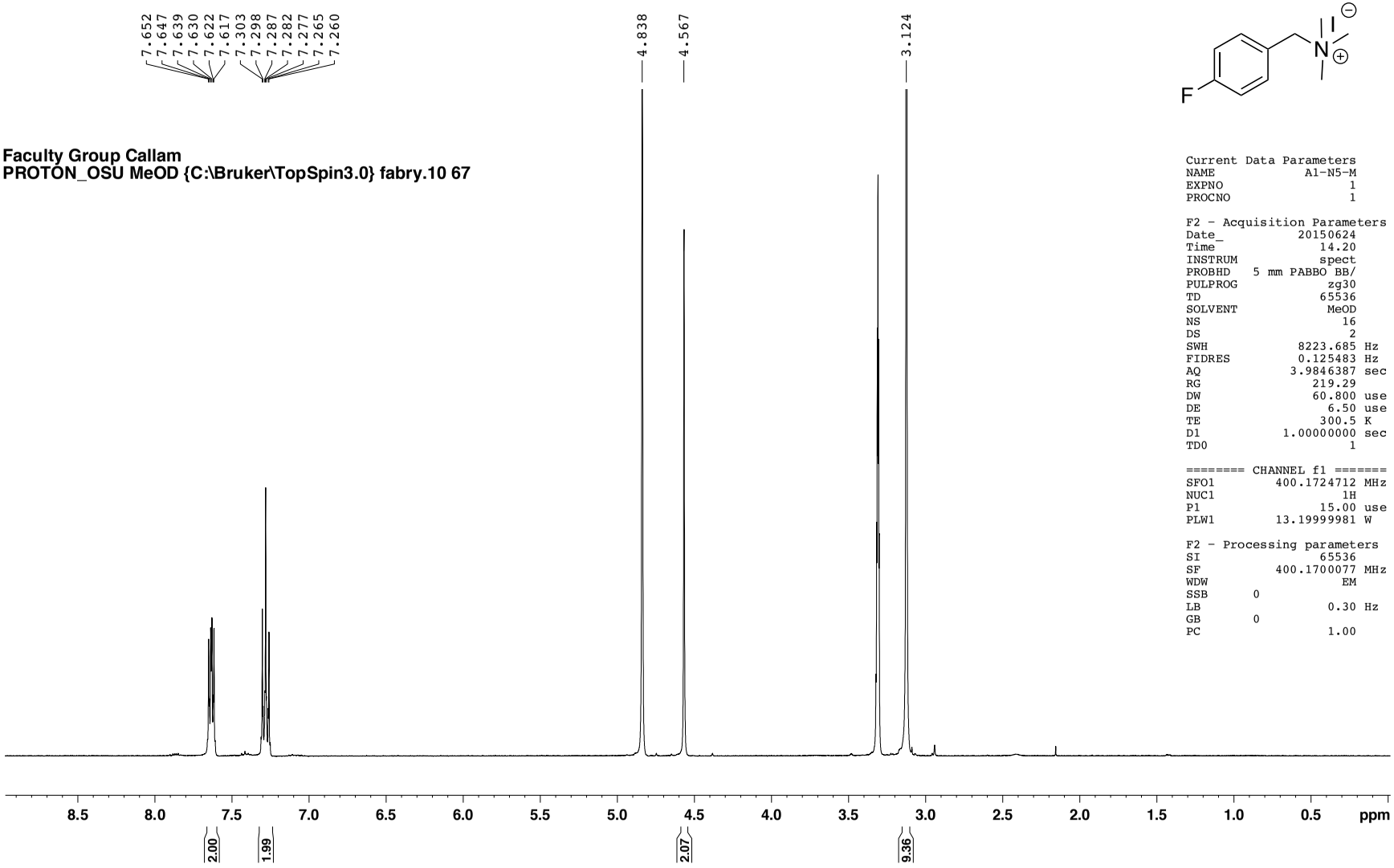
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 6

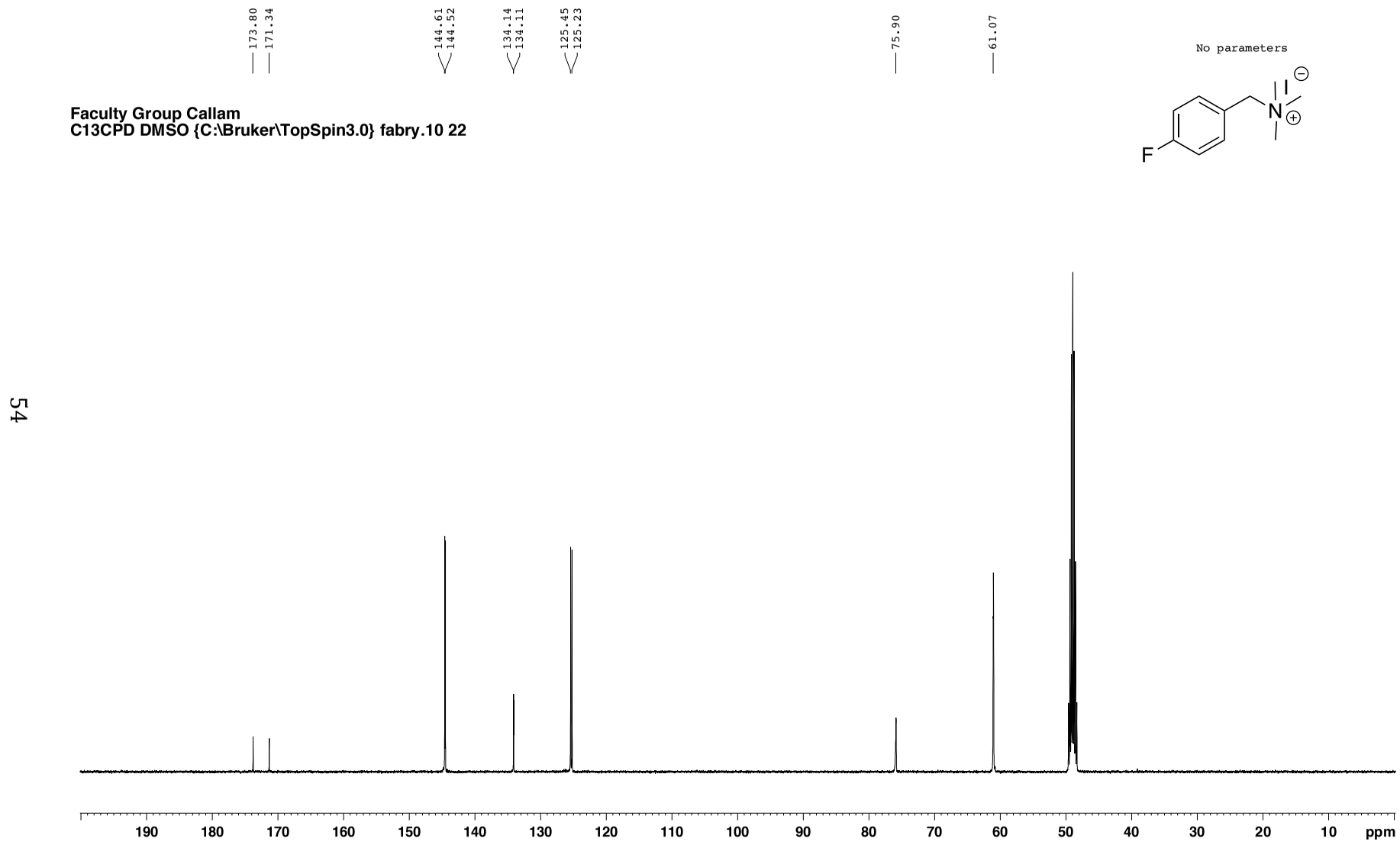


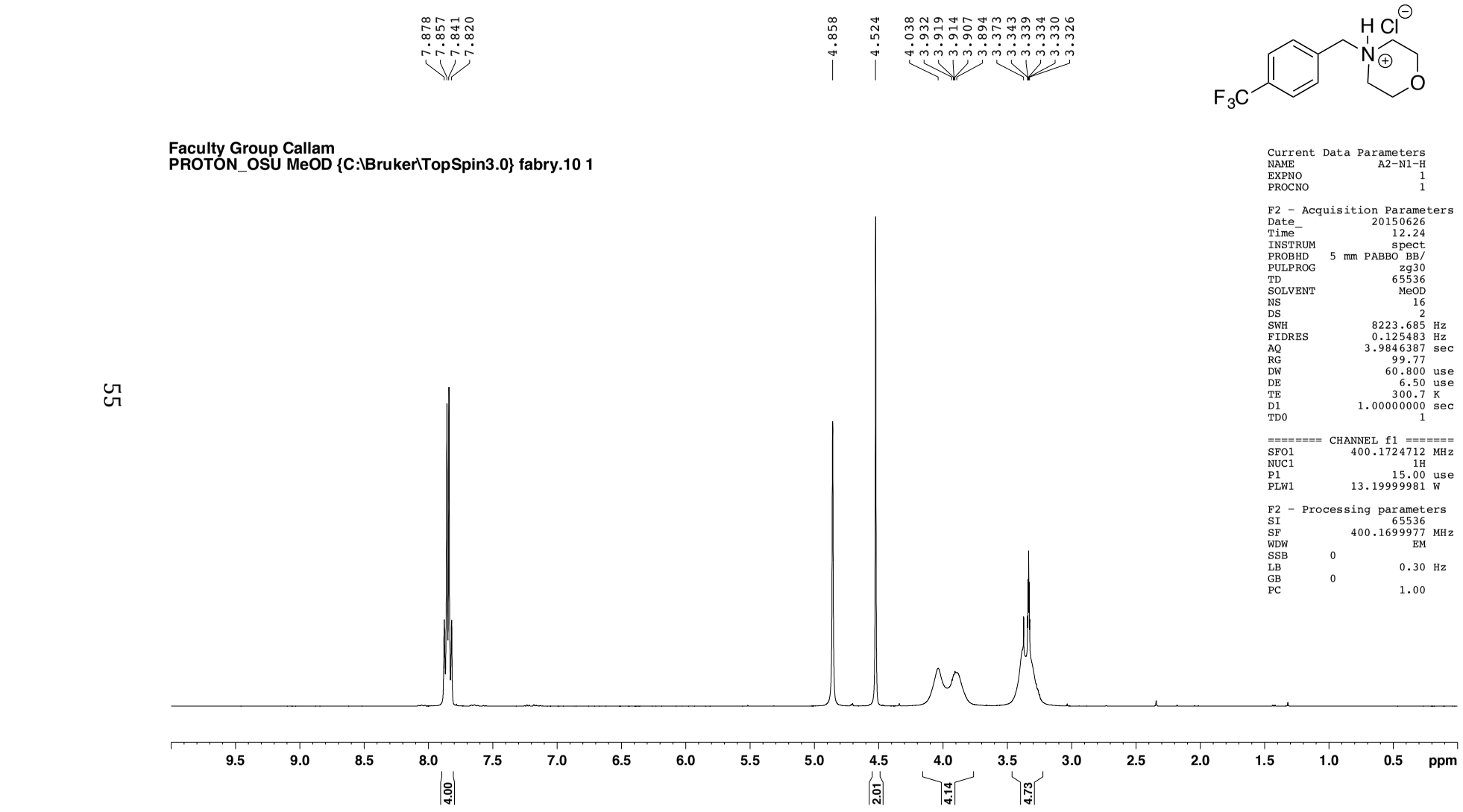



7.646
7.641
7.633
7.627
7.624
7.619
7.613
7.611
7.287
7.282
7.266
7.261
7.249
7.244
4.833
4.532
4.529
3.435
3.419
3.401
3.383
3.369
3.353
3.351
3.335
3.333
3.317
3.313
3.309
3.304
3.300
2.934
1.445
1.427
1.408
I
N
F
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 66
Current Data Parameters
NAME A1-N4-M
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150624
Time 14.15
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 188.13
DW 60.800 use
DE 6.50 use
TE 300.5 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1700081 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
1.96
2.04
3.50
0.08
3.01
6.14


Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 88
No parameters
166.66
164.18
136.57
124.95
117.35
117.13
64.97
57.12
47.46
9.65
F
ppm


7.652
7.647
7.639
7.630
7.622
7.617
7.303
7.298
7.287
7.282
7.277
7.265
7.260
4.838
4.567
3.124
F
N
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 67
Current Data Parameters
NAME A1-N5-M
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150624
Time 14.20
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 219.29
DW 60.800 use
DE 6.50 use
TE 300.5 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1700077 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
1.99
2.07
9.36

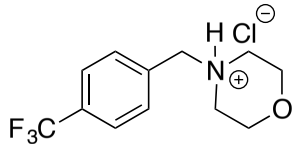

173.80
171.34
144.61
144.52
134.14
134.11
125.45
125.23
75.90
61.07
No parameters
Faculty Group Callam
C13CPD DMSO {C:\Bruker\TopSpin3.0} fabry.10 22
F
N
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

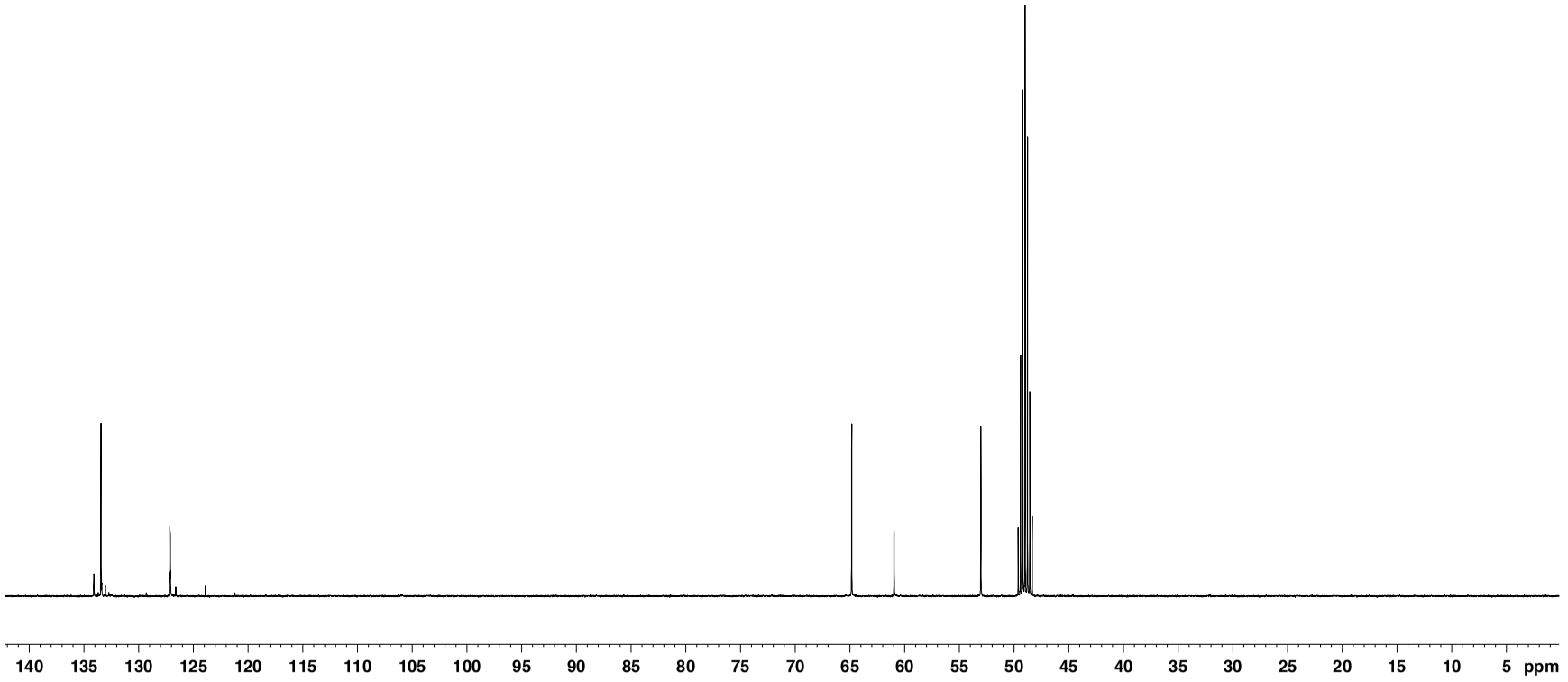

7.878
7.857
7.841
7.820
4.858
4.524
4.038
3.932
3.919
3.914
3.907
3.894
3.373
3.343
3.339
3.334
3.330
3.326
H Cl
N
O
F3C
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 1
Current Data Parameters
NAME A2-N1-H
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150626
Time 12.24
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 99.77
DW 60.800 use
DE 6.50 use
TE 300.7 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1699977 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
4.00
2.01
4.14
4.73

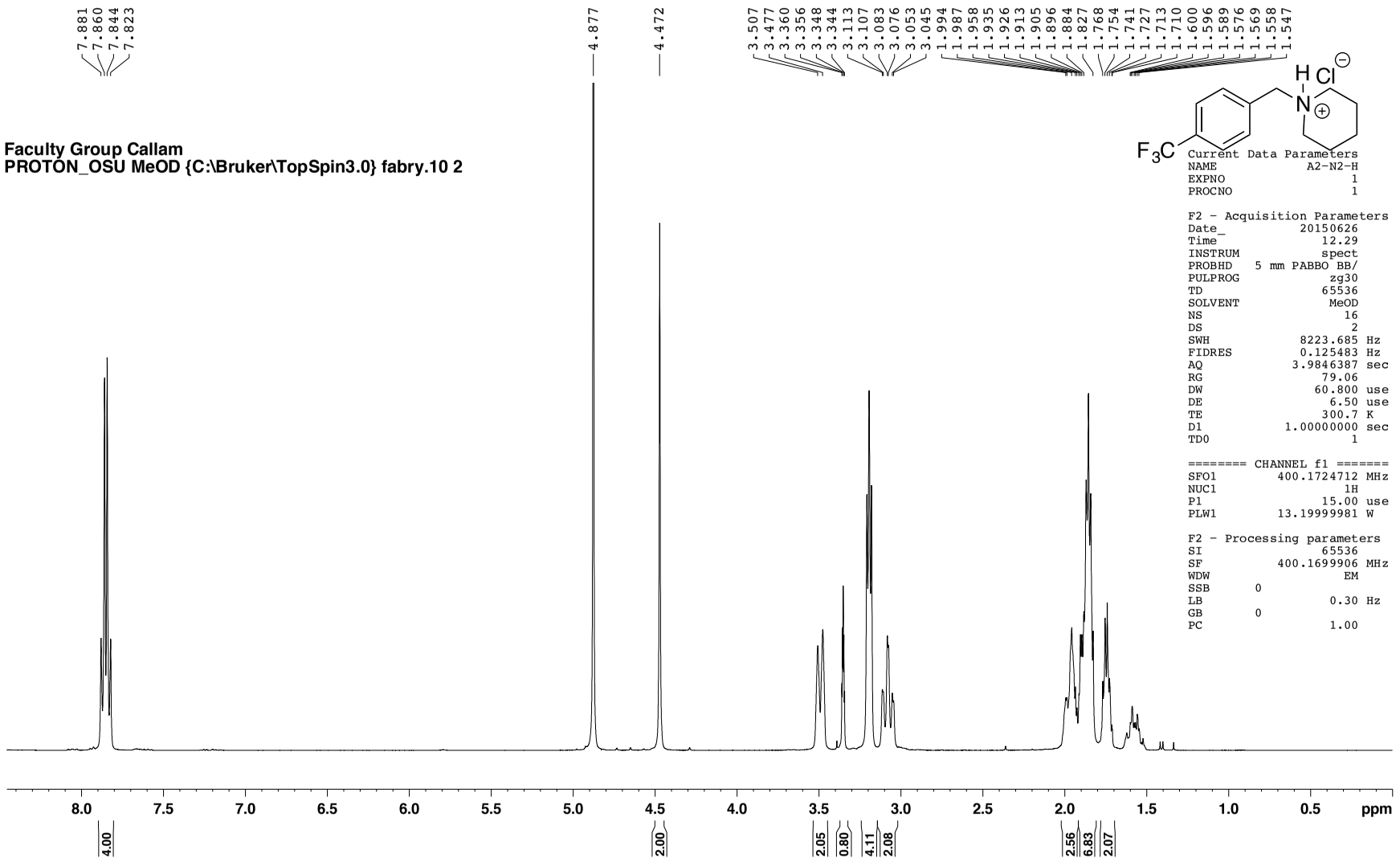
134.11
133.46
133.06
127.17
127.13
126.62
123.92
64.85
60.98
53.05

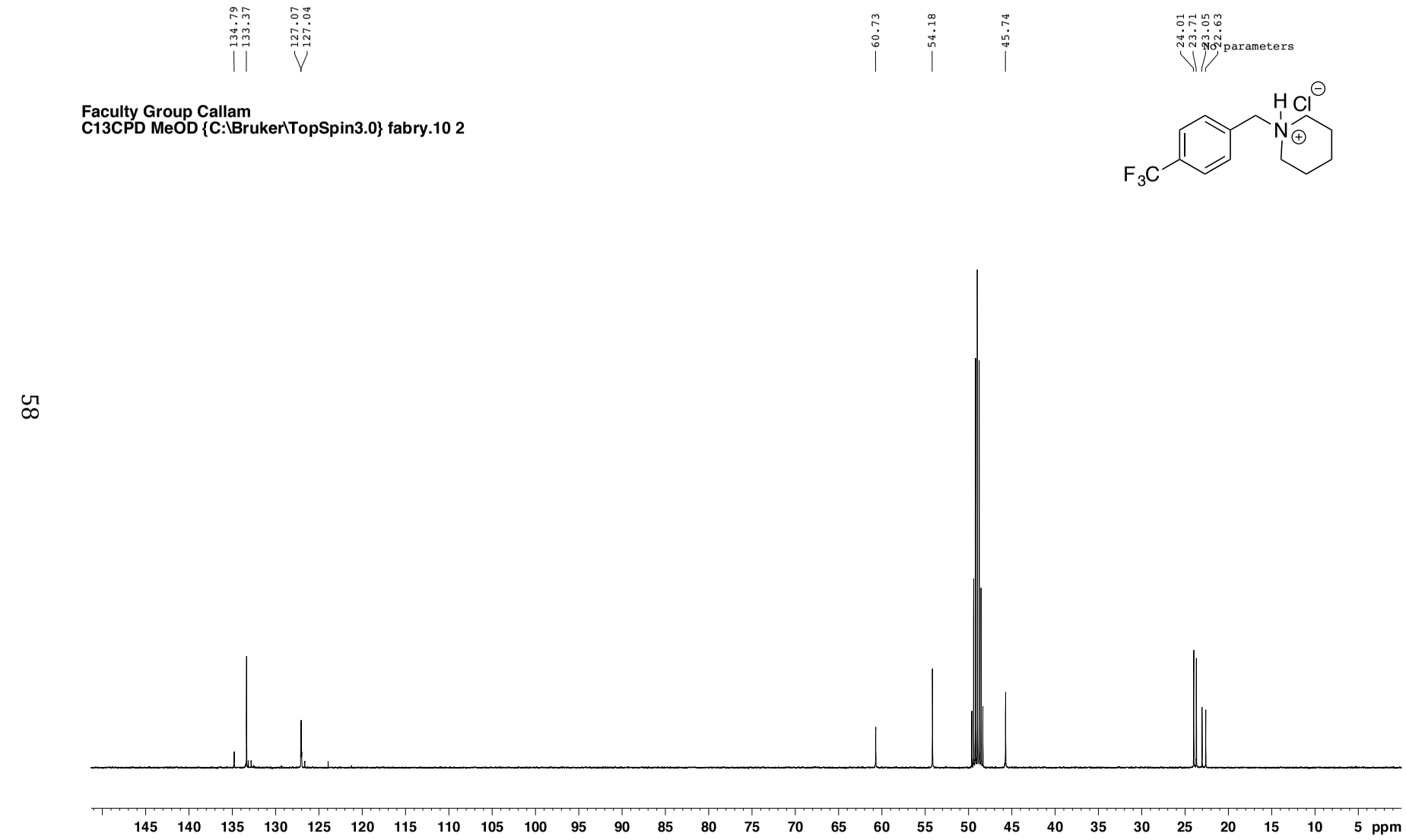
No parameters

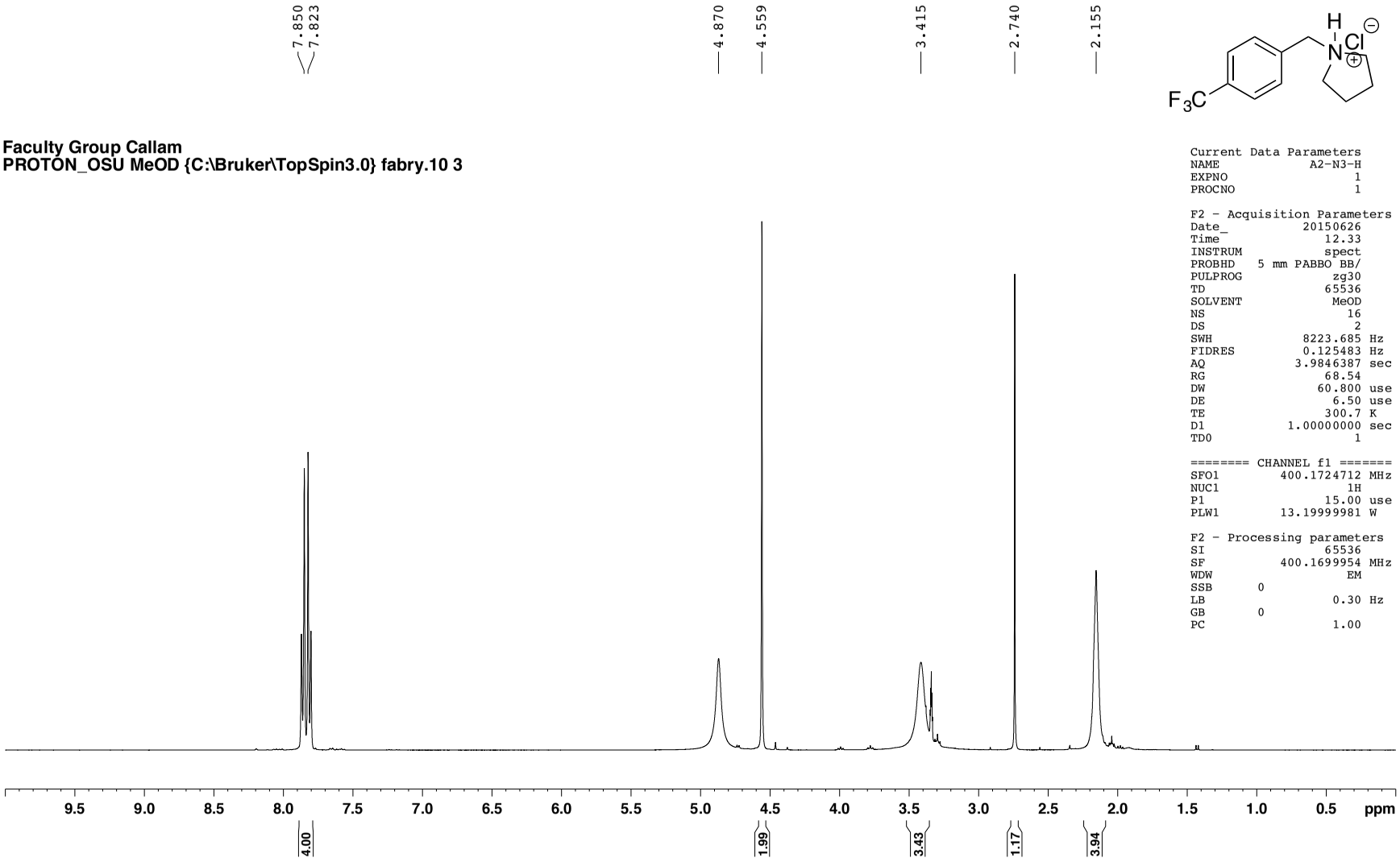
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 1





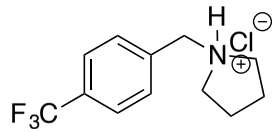

7.881
7.860
7.844
7.823
4.877
4.472
3.507
3.477
3.360
3.356
3.348
3.344
3.113
3.107
3.083
3.076
3.053
3.045
1.994
1.987
1.958
1.935
1.926
1.913
1.905
1.896
1.884
1.827
1.768
1.754
1.741
1.727
1.713
1.710
1.600
1.596
1.589
1.576
1.569
1.558
1.547
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 2
H Cl
N
F3C
Current Data Parameters
NAME A2-N2-H
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150626
Time 12.29
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 79.06
DW 60.800 use
DE 6.50 use
TE 300.7 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1699906 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
4.00
2.00
2.05
0.80
4.11
2.08
2.56
6.83
2.07

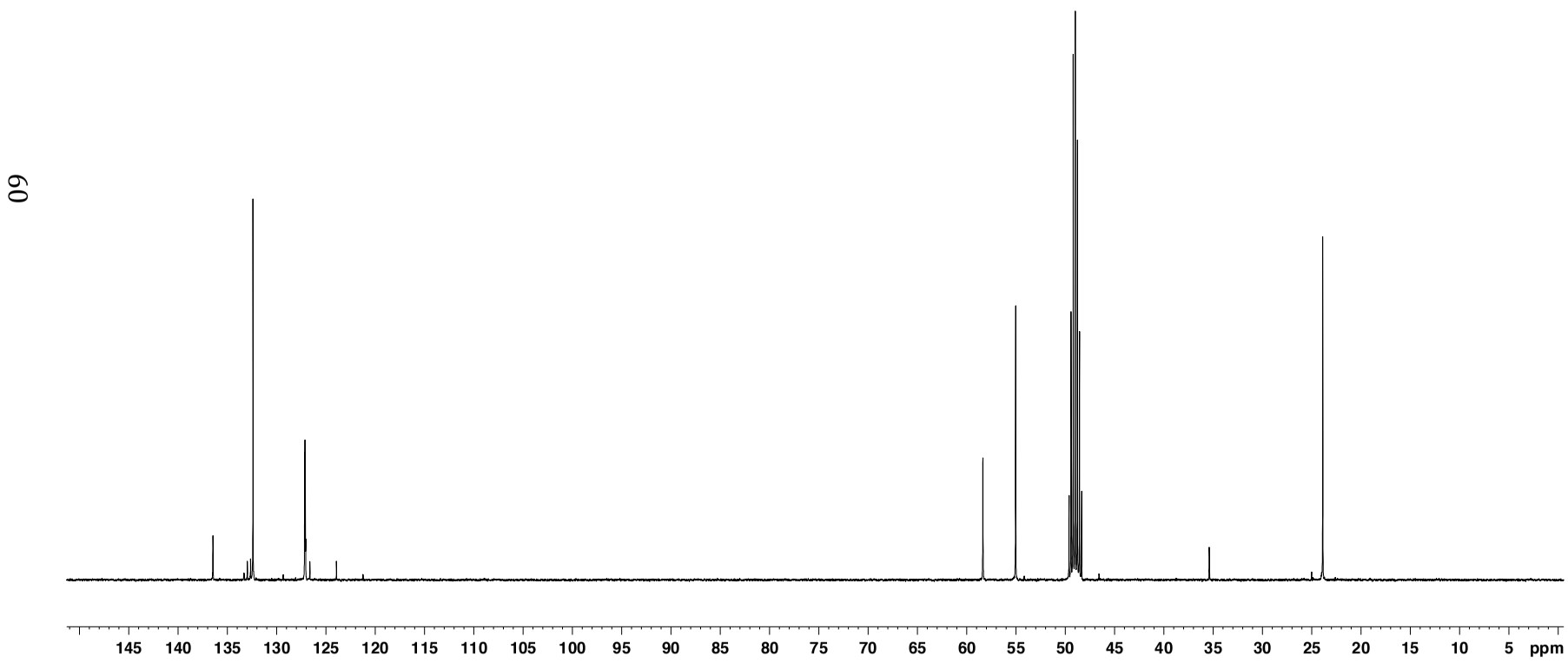

134.79
133.37
127.07
127.04
60.73
54.18
45.74
24.01
23.71
23.05
22.63
No parameters
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 2
H
Cl
N
F3C
145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 ppm

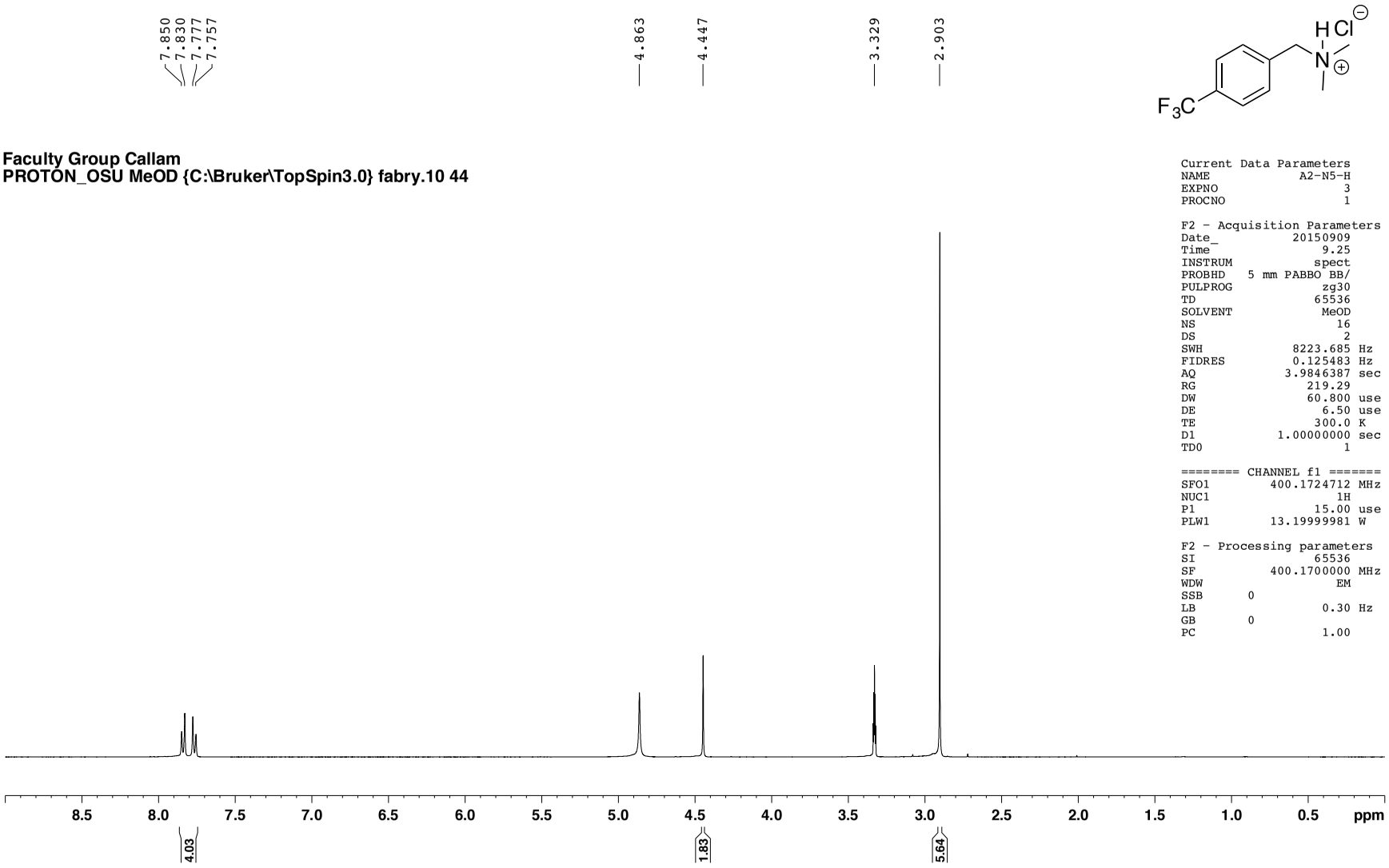

7.850
7.823
4.870
4.559
3.415
2.740
2.155
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 3
Current Data Parameters
NAME A2-N3-H
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150626
Time 12.33
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 68.54
DW 60.800 use
DE 6.50 use
TE 300.7 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1699954 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
4.00
1.99
3.43
1.17
3.94

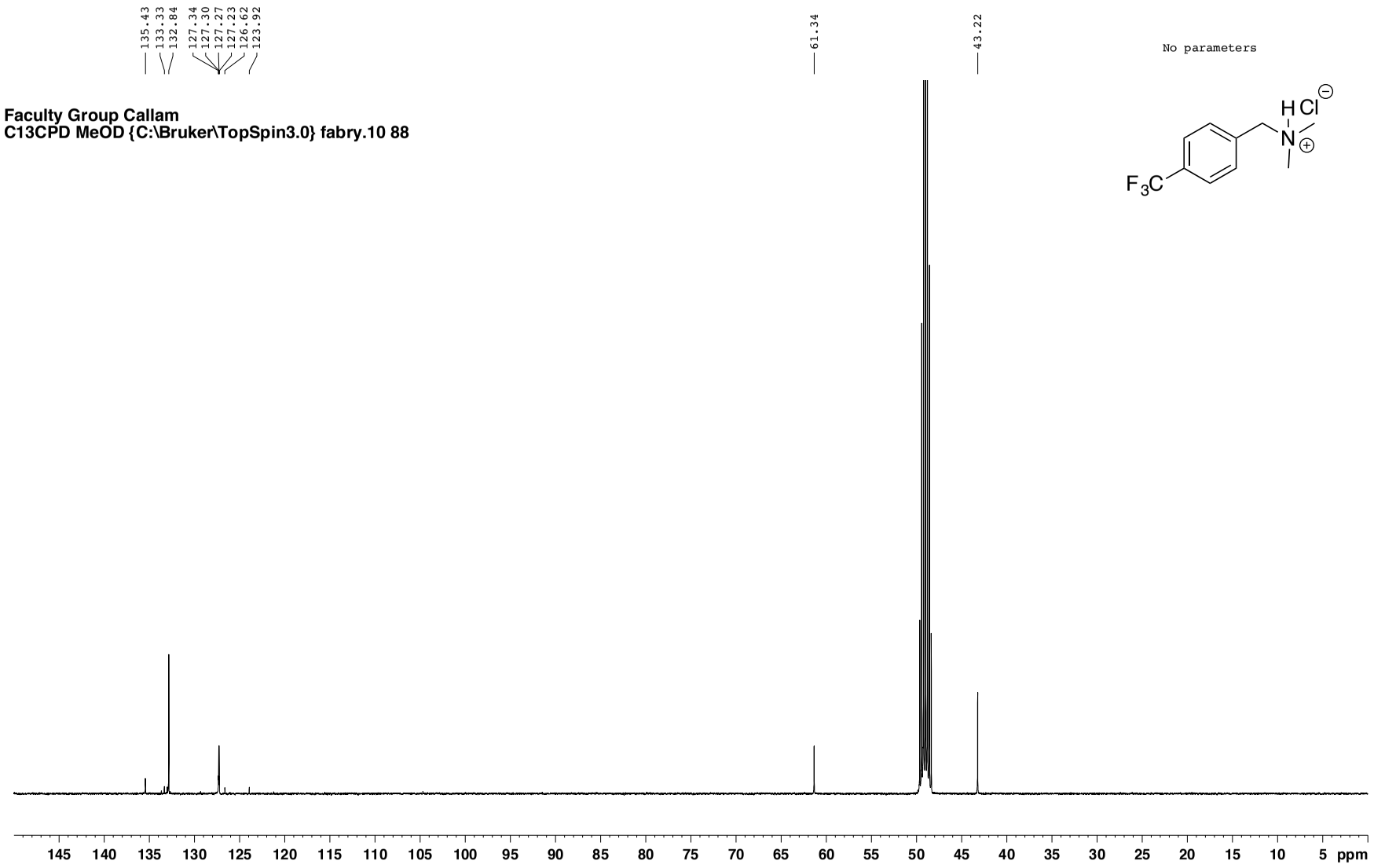
136.48
132.99
132.66
132.41
127.15
127.11
126.65
123.95
58.37
55.05
35.41
23.89
No parameters

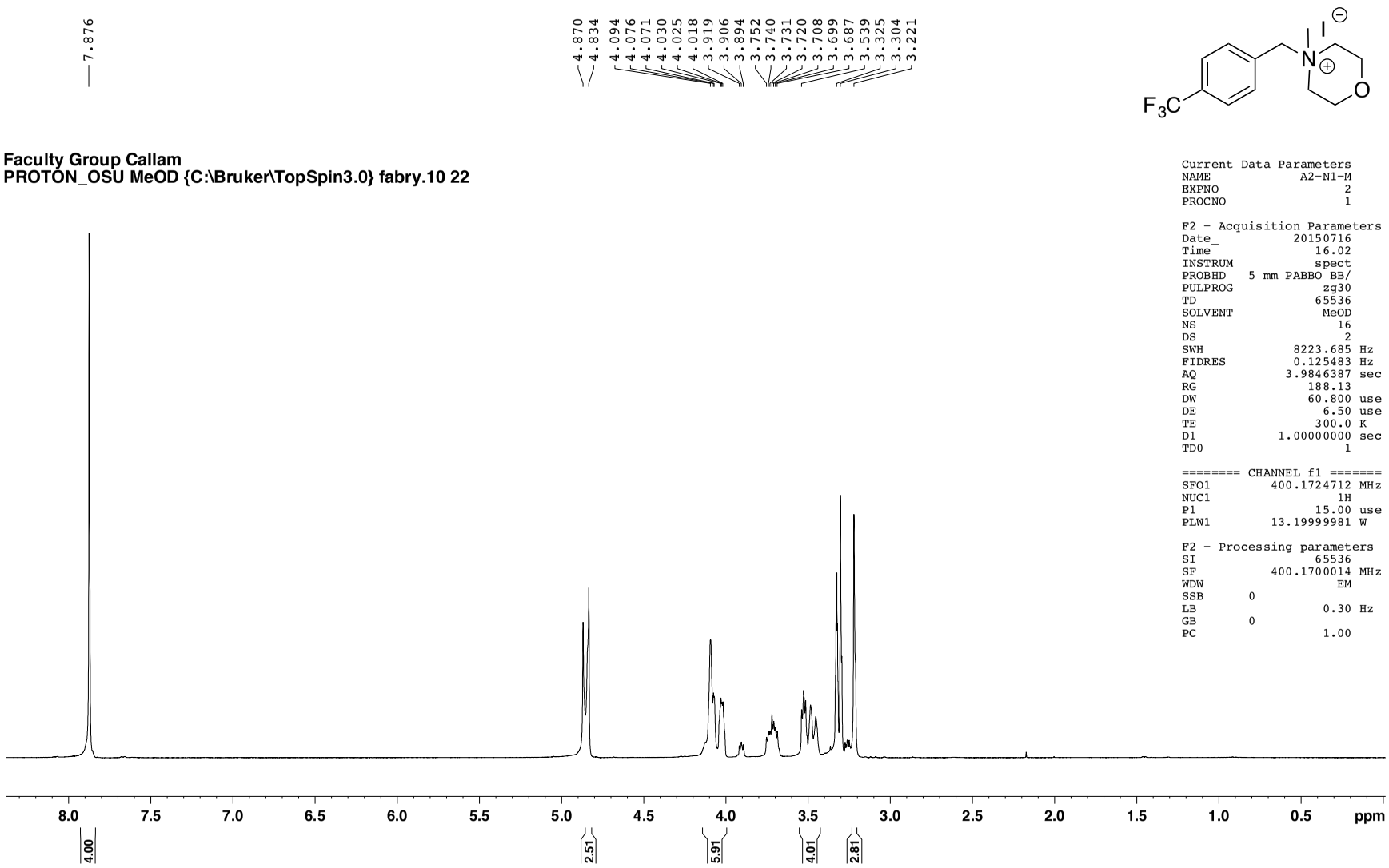
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 3






7.850
7.830
7.777
7.757
4.863
4.447
3.329
2.903
H Cl
N
F3C
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 44
Current Data Parameters
NAME A2-N5-H
EXPNO 3
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150909
Time 9.25
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 219.29
DW 60.800 use
DE 6.50 use
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1700000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
4.03
1.83
5.64

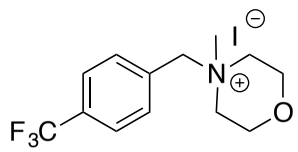

135.43
133.33
132.84
127.34
127.30
127.27
127.23
126.62
123.92
61.34
43.22
No parameters
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 88
H Cl
N
F3C
145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 ppm

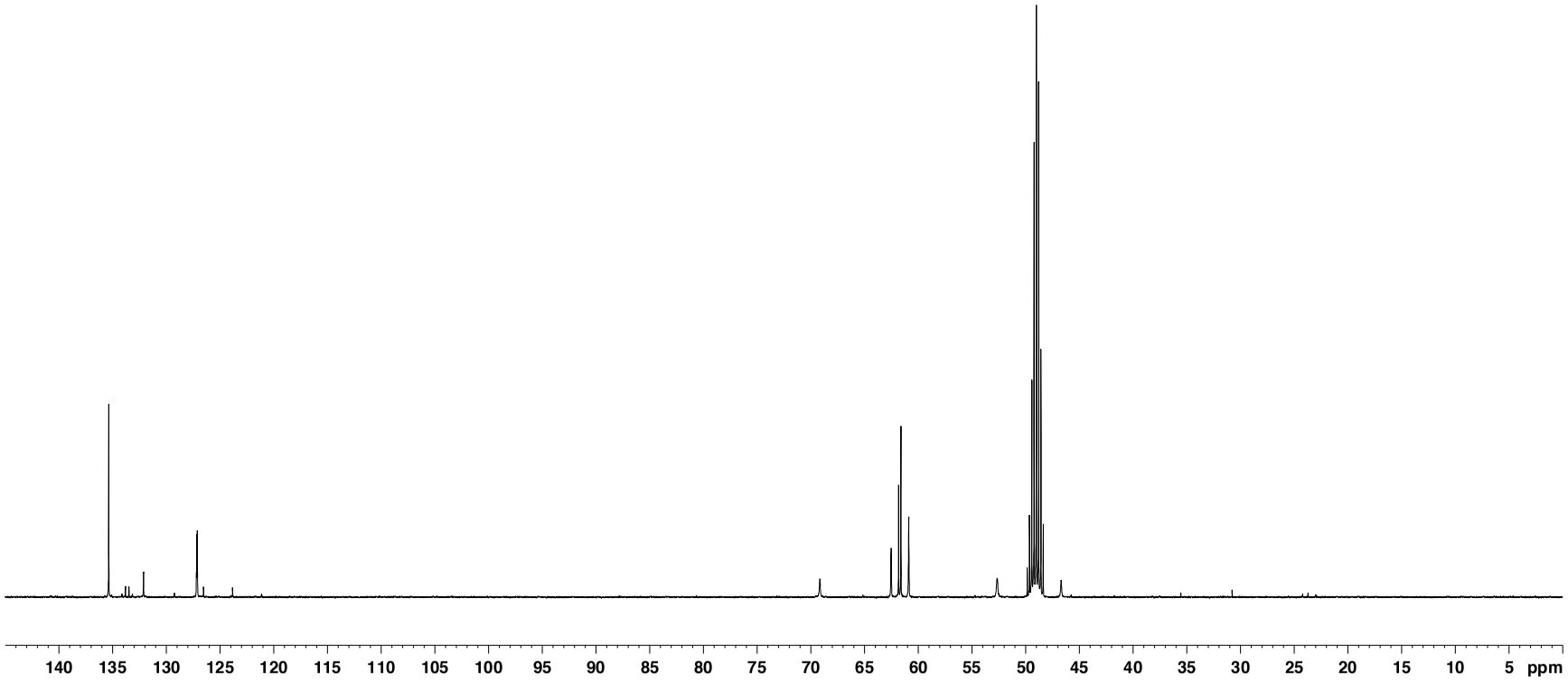

7.876
4.870
4.834
4.094
4.076
4.071
4.030
4.025
4.018
3.919
3.906
3.894
3.752
3.740
3.731
3.720
3.708
3.699
3.687
3.539
3.325
3.304
3.221
I
N
O
F3C
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 22
Current Data Parameters
NAME A2-N1-M
EXPNO 2
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150716
Time 16.02
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 188.13
DW 60.800 use
DE 6.50 use
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1700014 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
4.00
2.51
5.91
4.01
2.81

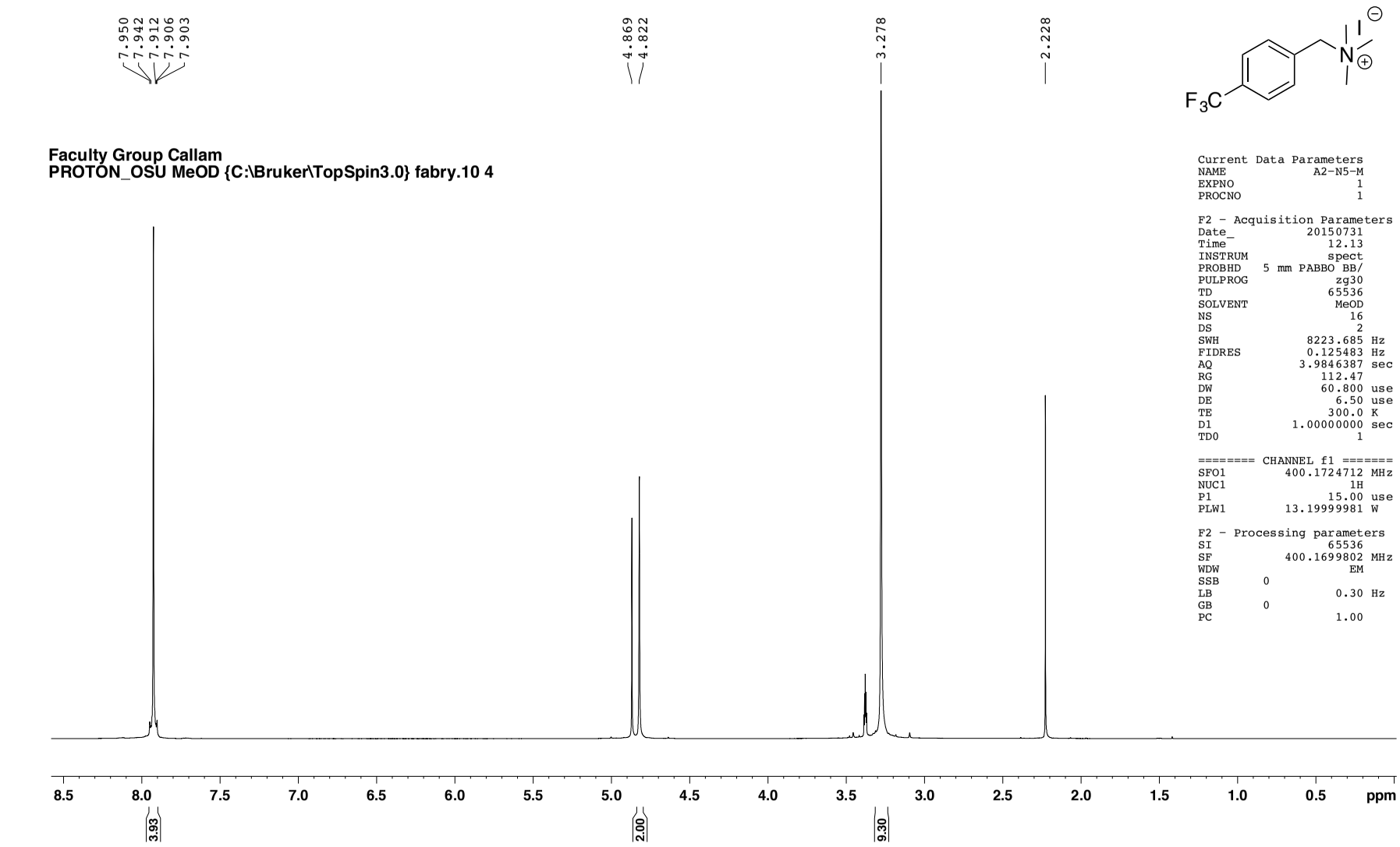
135.36
133.80
133.48
132.12
127.16
127.12
126.54
123.83
69.15
62.52
61.82
61.61
60.88
52.65
46.69

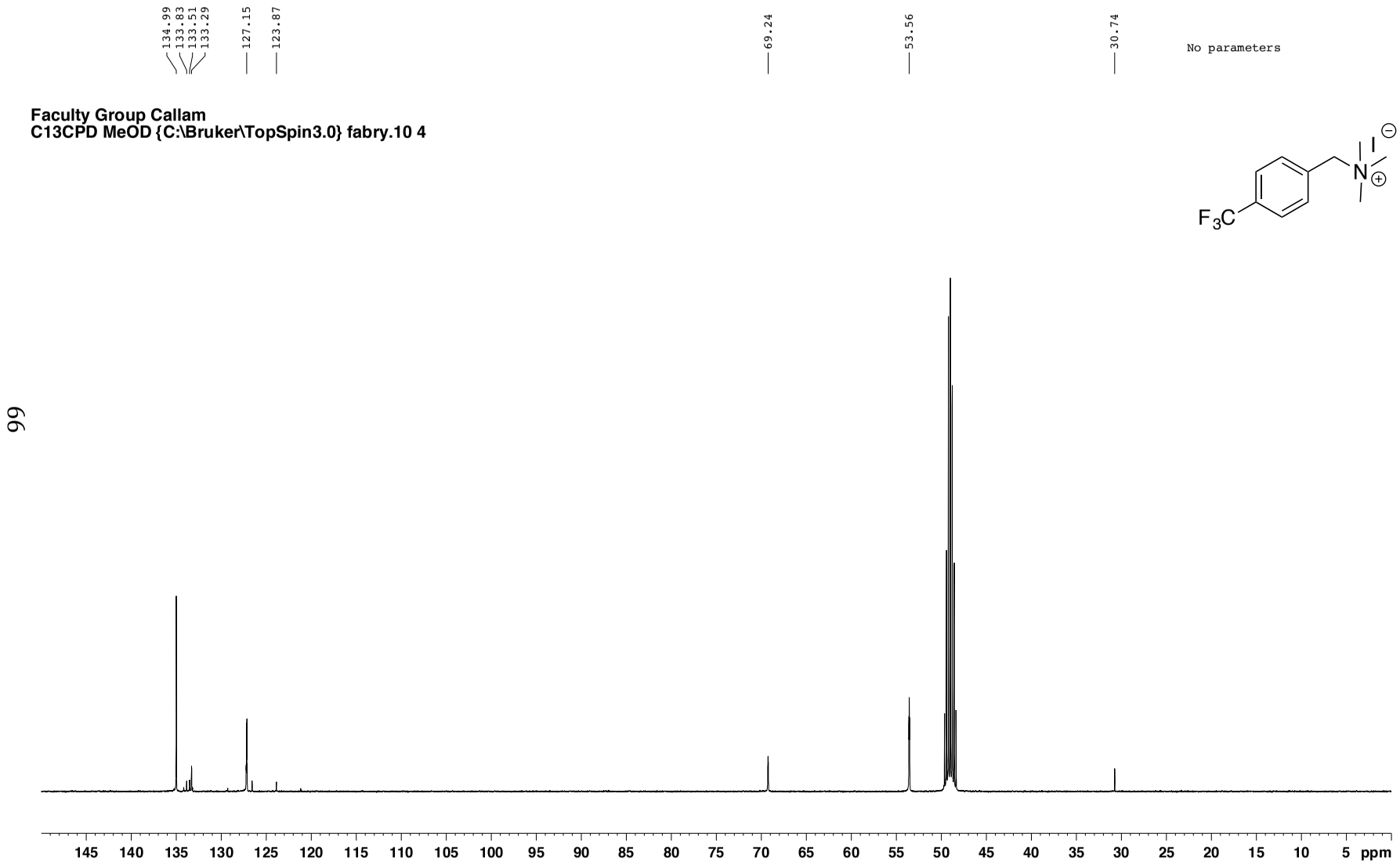
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 37

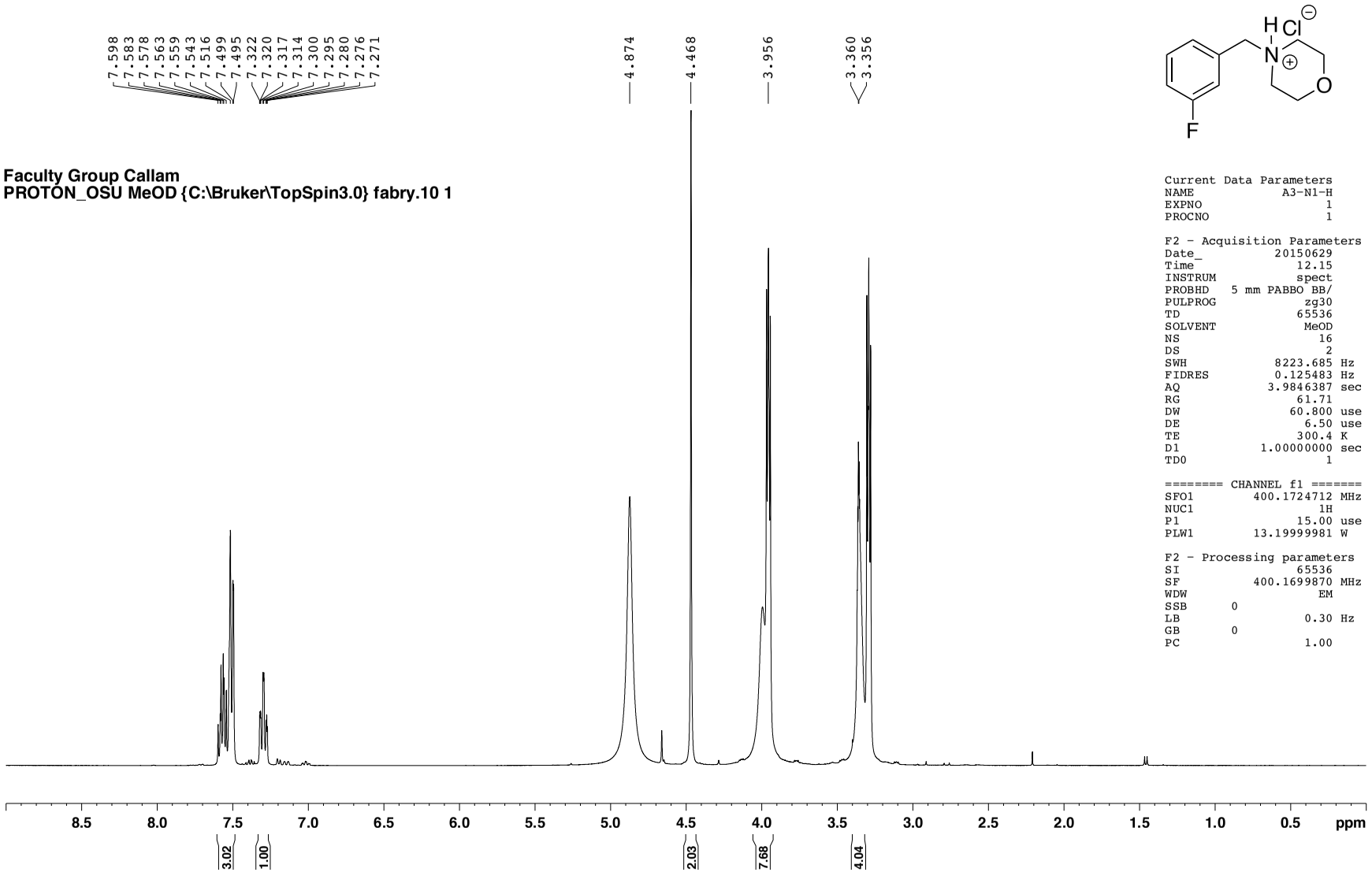
No parameters



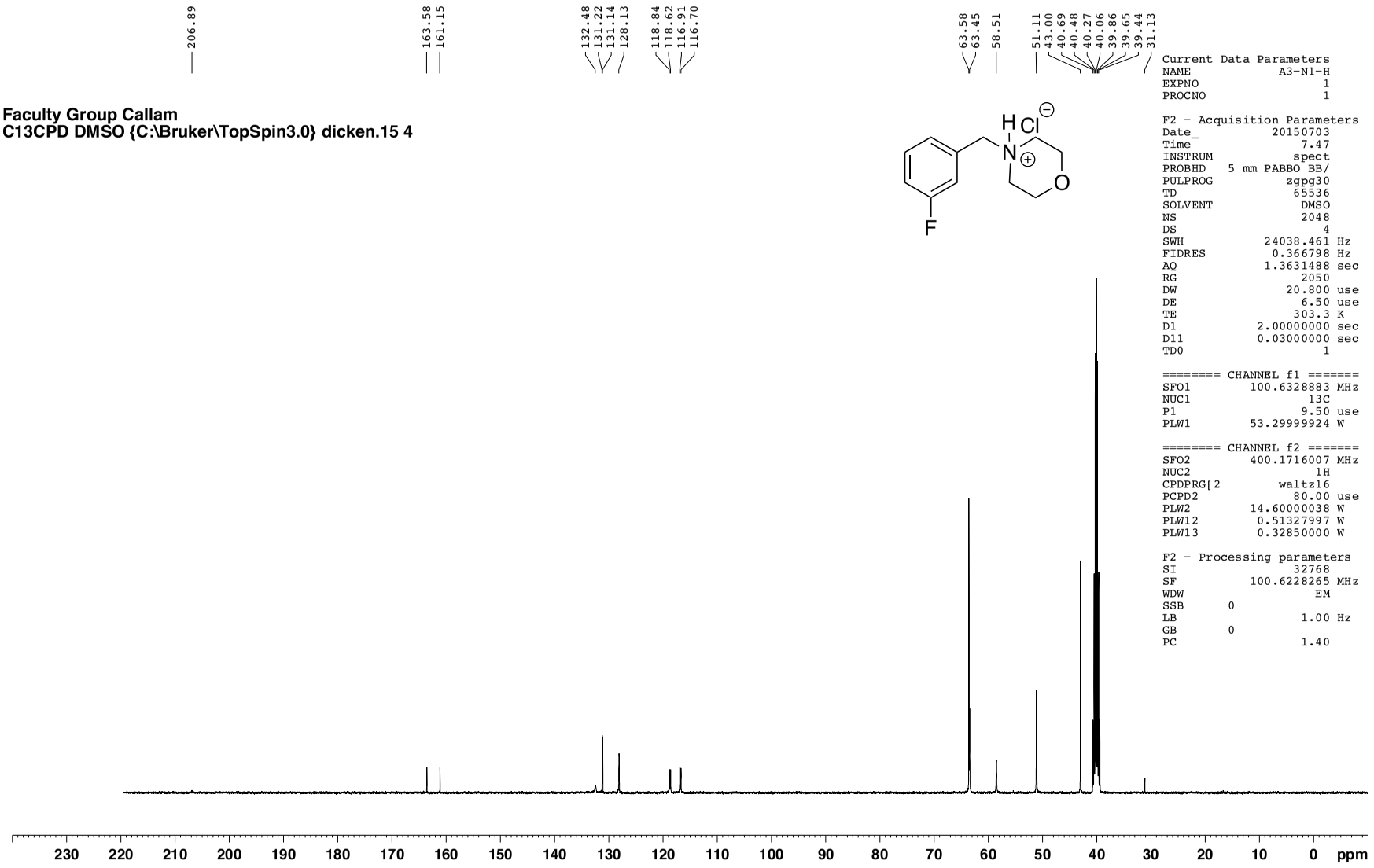



7.950
7.942
7.912
7.906
7.903
4.869
4.822
3.278
2.228
F3C
N
I
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 4
Current Data Parameters
NAME A2-N5-M
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150731
Time 12.13
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 112.47
DW 60.800 use
DE 6.50 use
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1699802 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
3.93
2.00
9.30

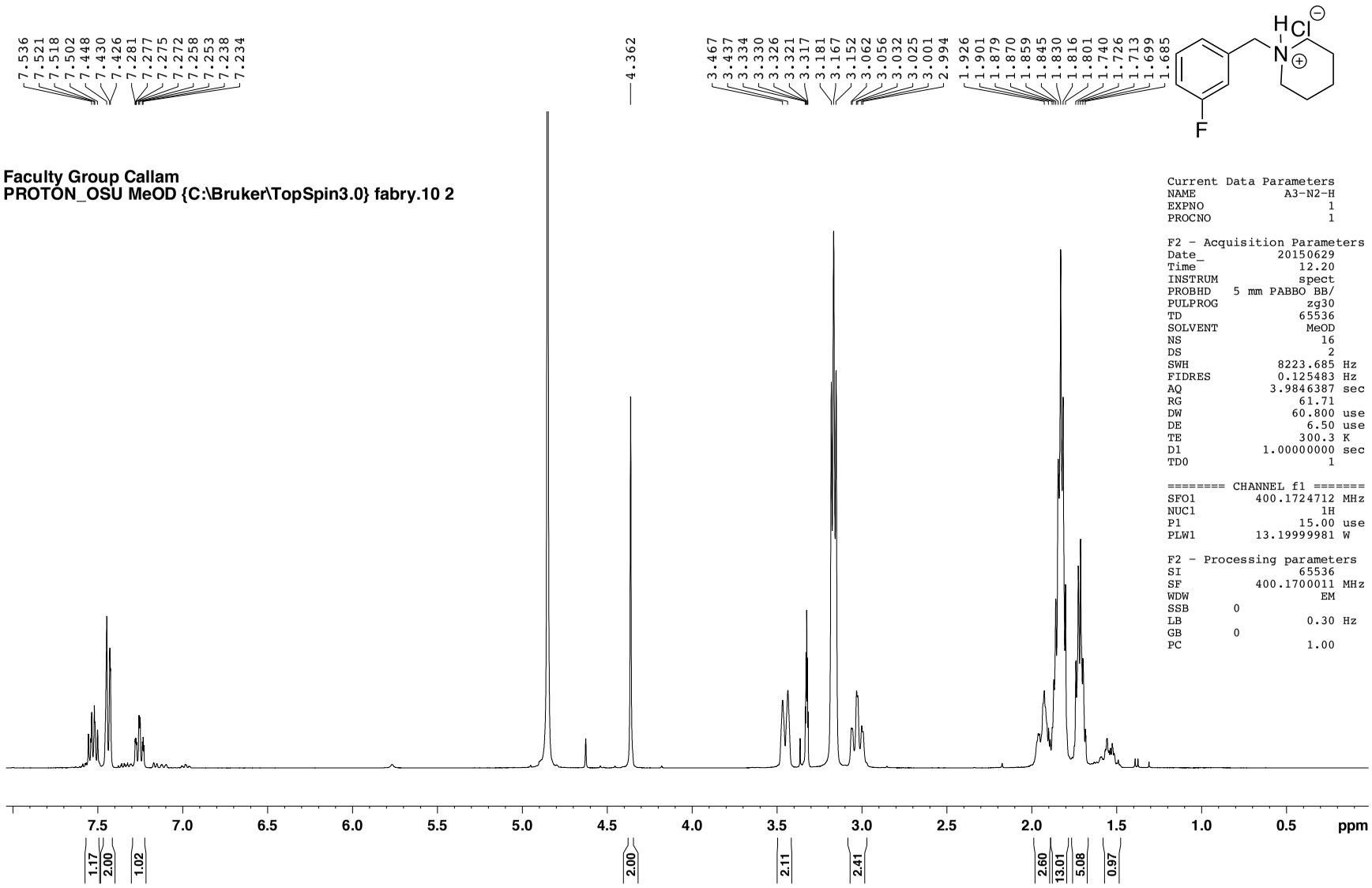

134.99
133.83
133.51
133.29
127.15
123.87
69.24
53.56
30.74
No parameters
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 4
F3C
N
I
99
145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 ppm

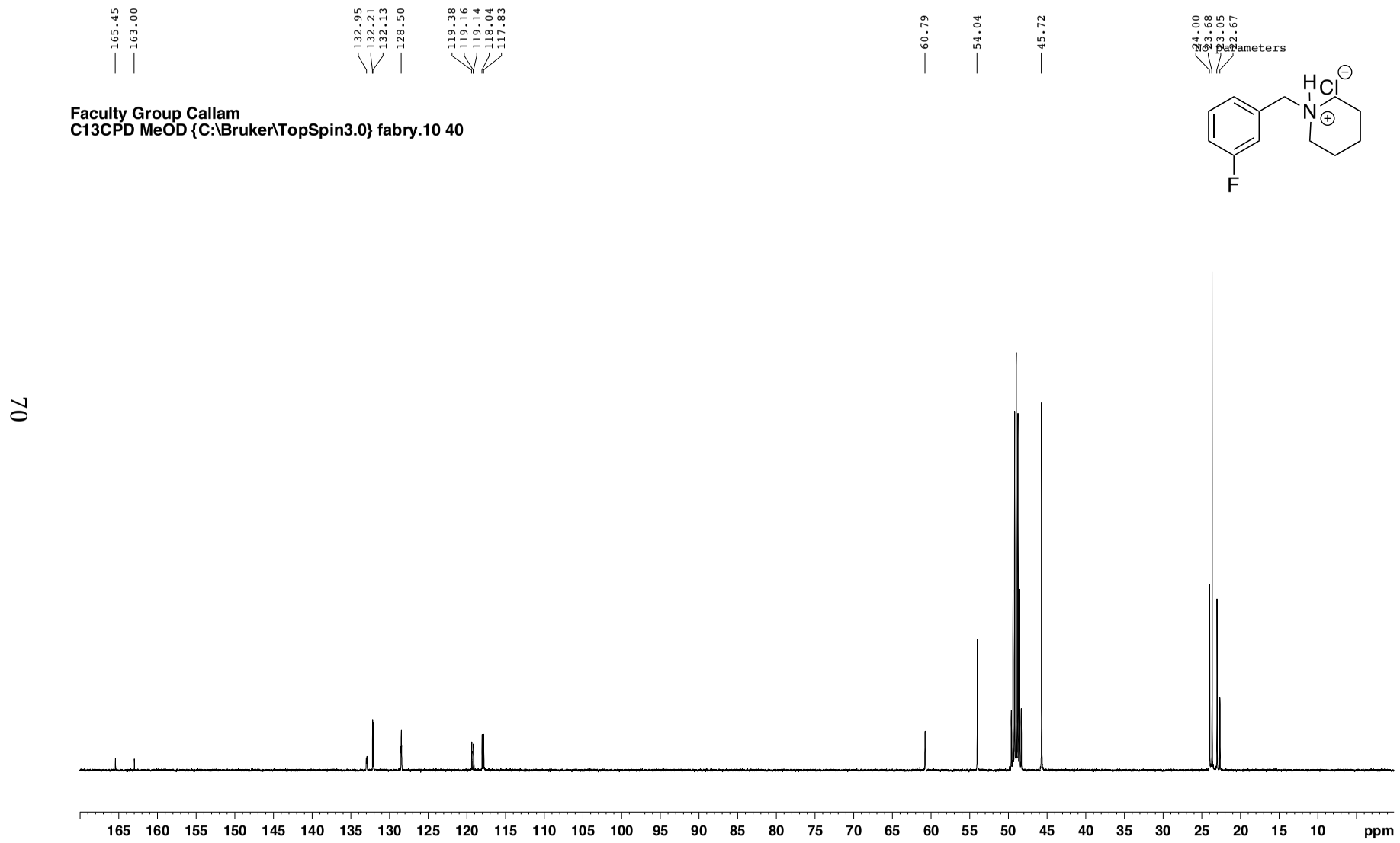

7.598
7.583
7.578
7.563
7.559
7.543
7.516
7.499
7.495
7.322
7.320
7.317
7.314
7.300
7.295
7.280
7.276
7.271
4.874
4.468
3.956
3.360
3.356
H
Cl
N
O
F
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 1
Current Data Parameters
NAME A3-N1-H
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150629
Time 12.15
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 61.71
DW 60.800 use
DE 6.50 use
TE 300.4 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1699870 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
3.02
1.00
2.03
7.68
4.04

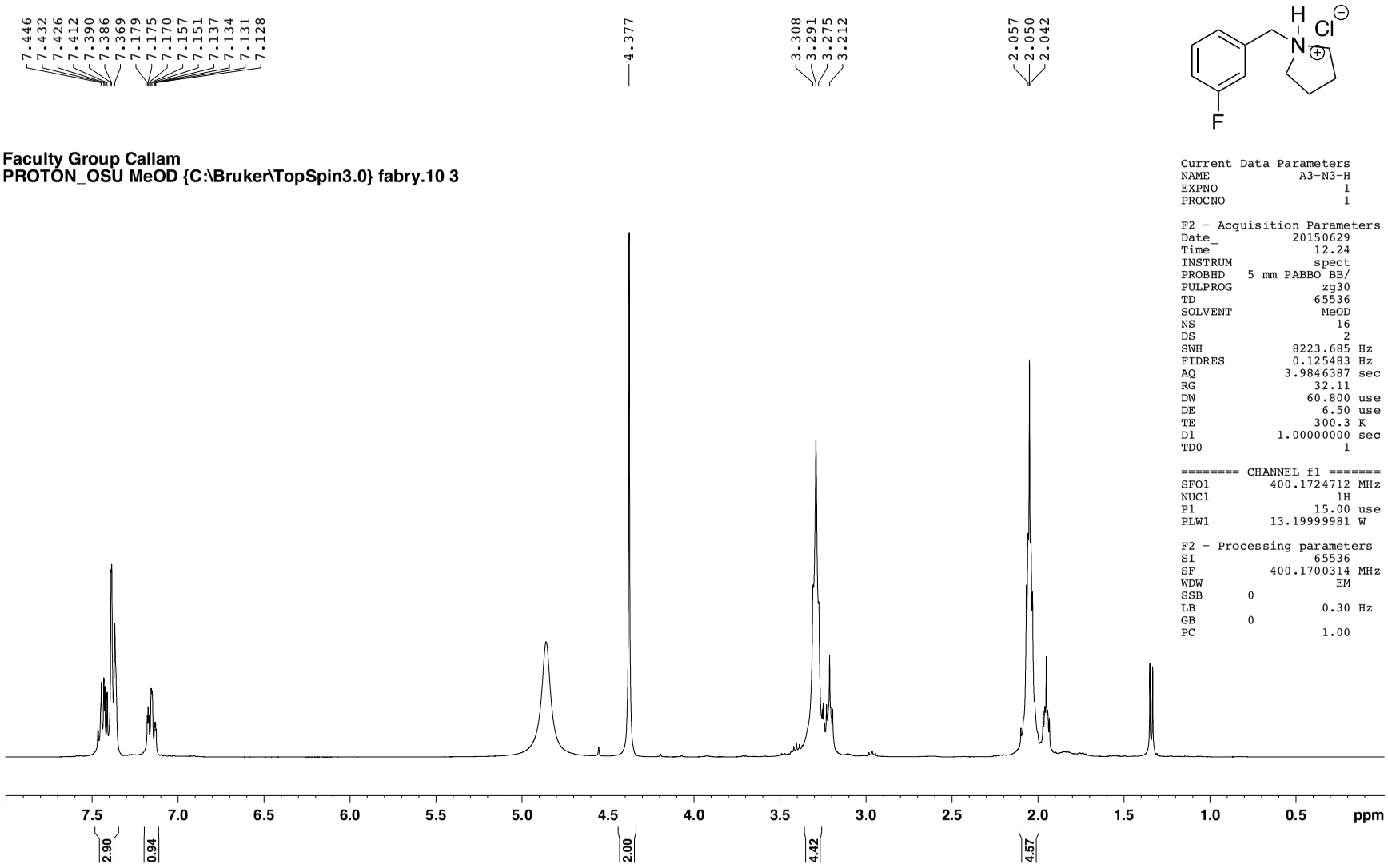
Faculty Group Callam
C13CPD DMSO {C:\Bruker\TopSpin3.0} dicken.15 4



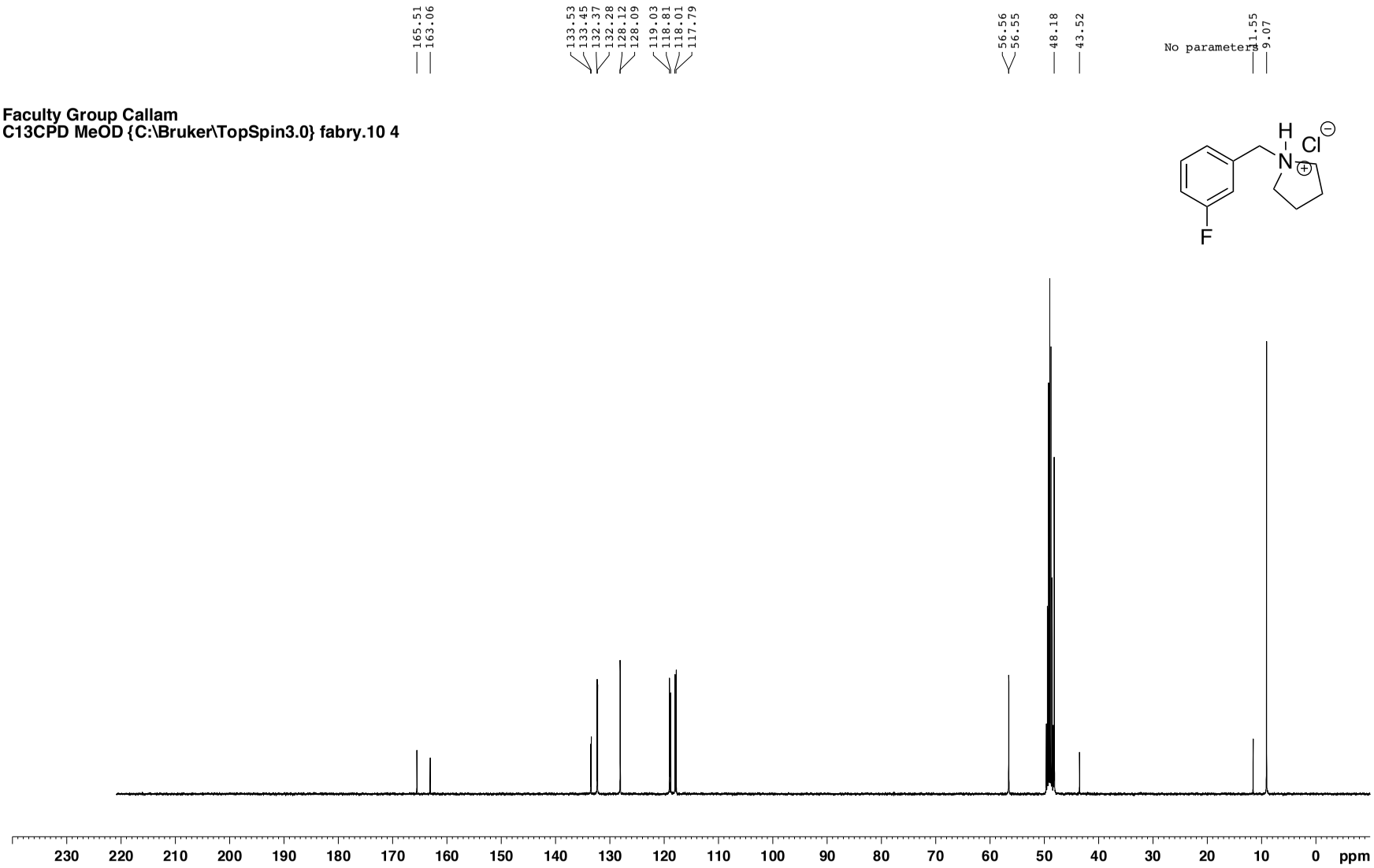

```
Current Data Parameters
NAME                  A3-N1-H
EXPNO                       1
PROCNO                      1

F2 - Acquisition Parameters
Date_              20150703
Time                   7.47
INSTRUM               spect
PROBHD   5 mm PABBO BB/
PULPROG             zgpg30
TD                   65536
SOLVENT                DMSO
NS                     2048
DS                        4
SWH              24038.461 Hz
FIDRES            0.366798 Hz
AQ                1.3631488 sec
RG                     2050
DW                   20.800 use
DE                    6.50 use
TE                   303.3 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                       1

======== CHANNEL f1 =======
SFO1           100.6328883 MHz
NUC1                   13C
P1                    9.50 use
PLW1          53.29999924 W

======== CHANNEL f2 =======
SFO2           400.1716007 MHz
NUC2                   1H
CPDPRG[2           waltz16
PCPD2                80.00 use
PLW2          14.60000038 W
PLW12          0.51327997 W
PLW13          0.32850000 W

F2 - Processing parameters
SI                    32768
SF             100.6228265 MHz
WDW                      EM
SSB       0
LB                    1.00 Hz
GB        0
PC                    1.40
```

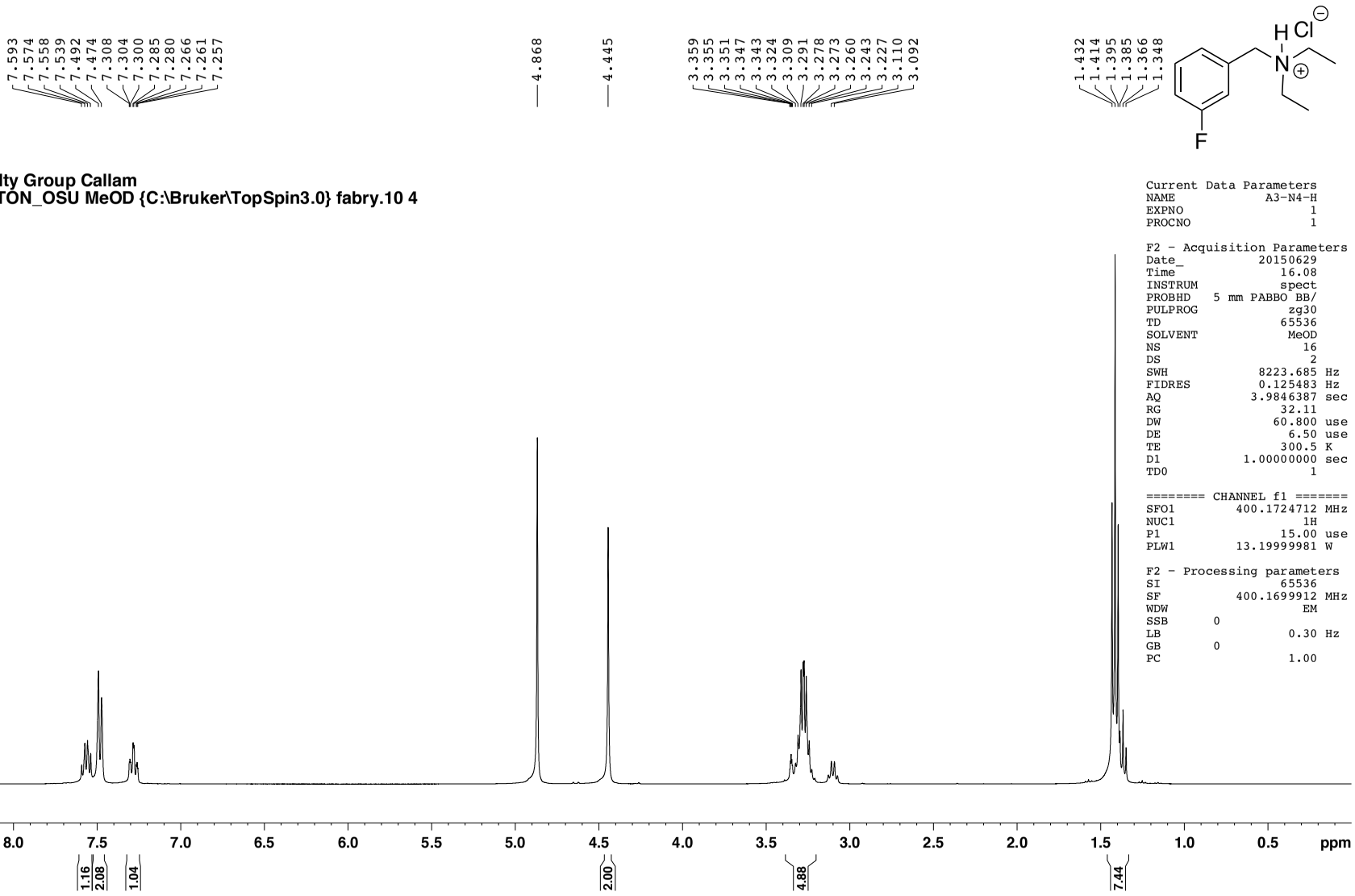

7.536
7.521
7.518
7.502
7.448
7.430
7.426
7.281
7.277
7.275
7.272
7.258
7.253
7.238
7.234
4.362
3.467
3.437
3.334
3.330
3.326
3.321
3.317
3.181
3.167
3.152
3.062
3.056
3.032
3.025
3.001
2.994
1.926
1.901
1.879
1.870
1.859
1.845
1.830
1.816
1.801
1.740
1.726
1.713
1.699
1.685
H
Cl
N
F
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 2
Current Data Parameters
NAME A3-N2-H
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150629
Time 12.20
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 61.71
DW 60.800 use
DE 6.50 use
TE 300.3 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1700011 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.17
2.00
1.02
2.00
2.11
2.41
2.60
13.01
5.08
0.97


165.45
163.00
132.95
132.21
132.13
128.50
119.38
119.16
119.14
118.04
117.83
60.79
54.04
45.72
24.00
23.68
23.05
22.67
No parameters
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 40
H
Cl
N
F
70
165 160 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 ppm

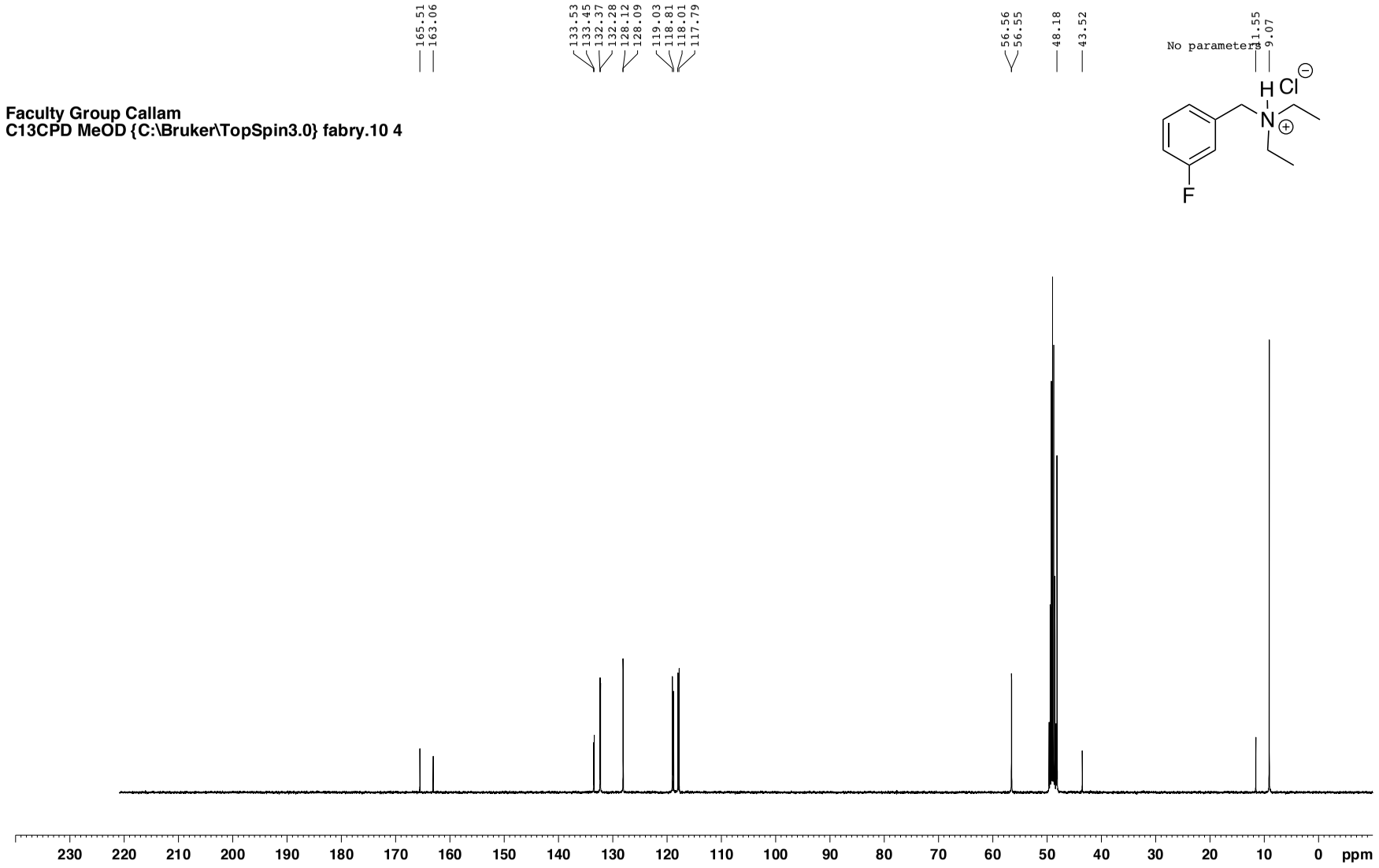

7.446
7.432
7.426
7.412
7.390
7.386
7.369
7.179
7.175
7.170
7.157
7.151
7.137
7.134
7.131
7.128
4.377
3.308
3.291
3.275
3.212
2.057
2.050
2.042
H
Cl
N
F
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 3
Current Data Parameters
NAME A3-N3-H
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150629
Time 12.24
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 32.11
DW 60.800 use
DE 6.50 use
TE 300.3 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1700314 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.90
0.94
2.00
4.42
4.57

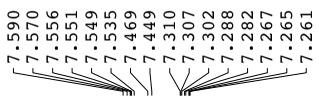
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 4

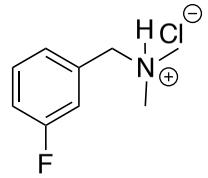



7.593
7.574
7.558
7.539
7.492
7.474
7.308
7.304
7.300
7.285
7.280
7.266
7.261
7.257
4.868
4.445
3.359
3.355
3.351
3.347
3.343
3.324
3.309
3.291
3.278
3.273
3.260
3.243
3.227
3.110
3.092
1.432
1.414
1.395
1.385
1.366
1.348
H Cl
N
F
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 4
Current Data Parameters
NAME A3-N4-H
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150629
Time 16.08
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 32.11
DW 60.800 use
DE 6.50 use
TE 300.5 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1699912 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.16
2.08
1.04
2.00
4.88
7.44

Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 4

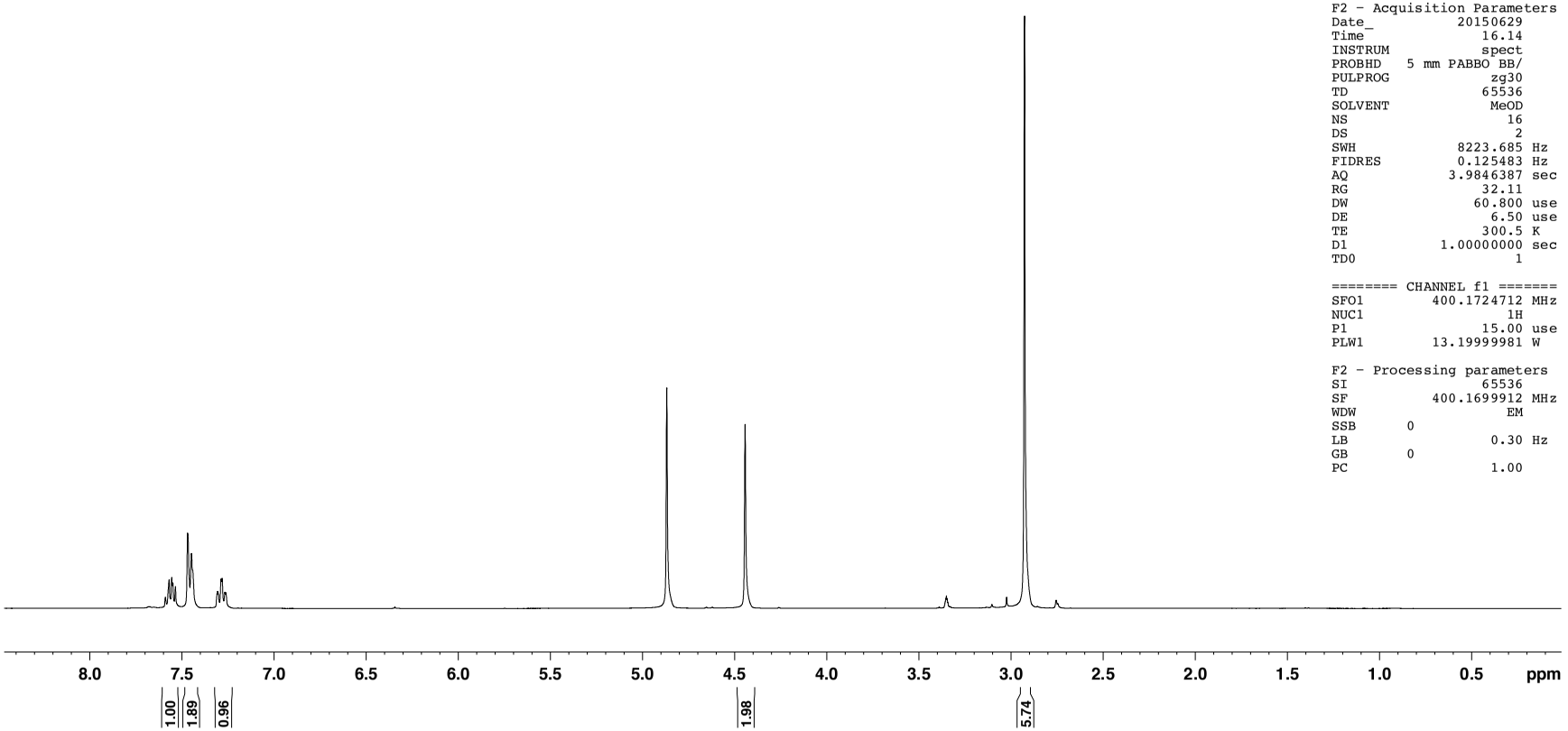


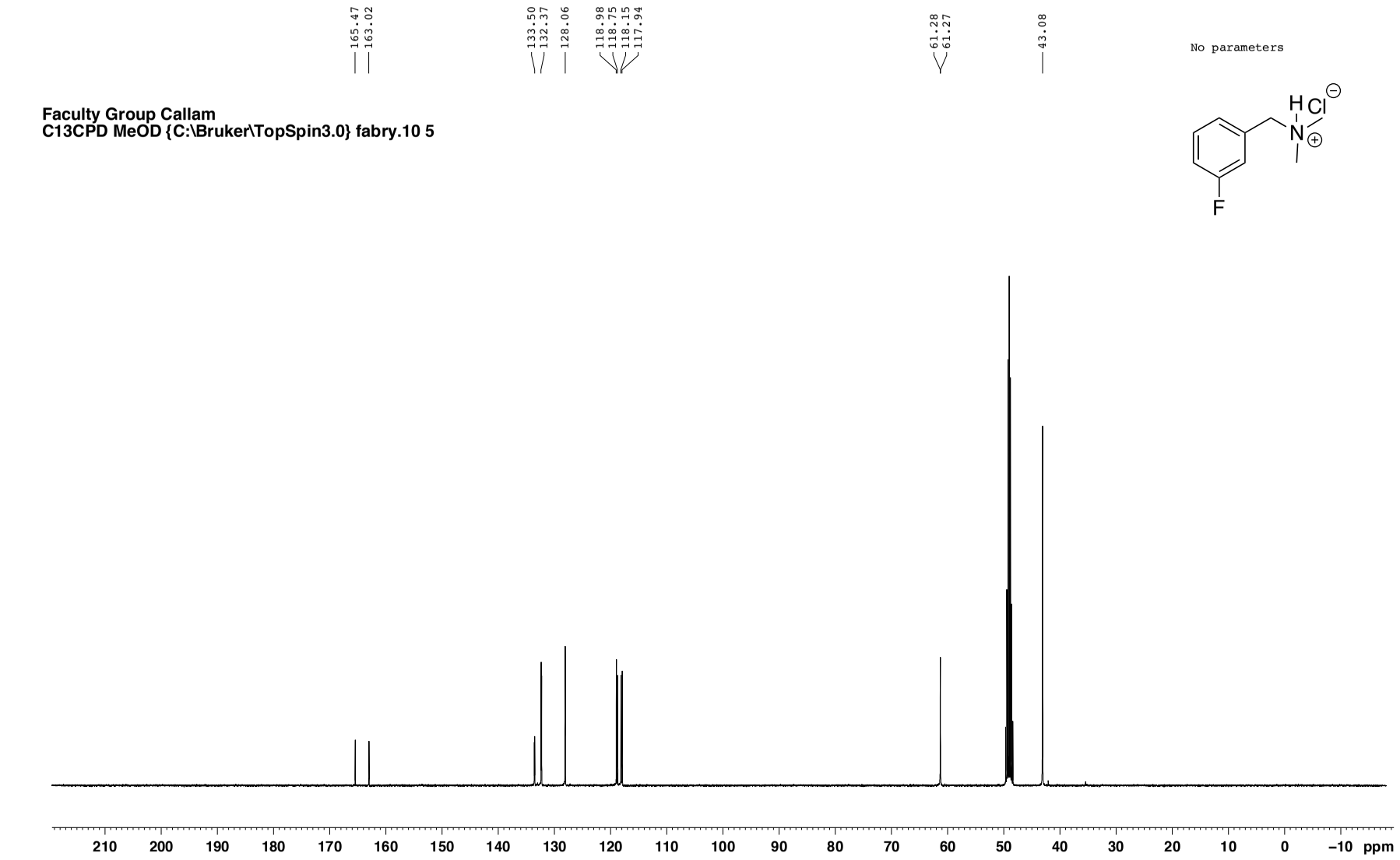


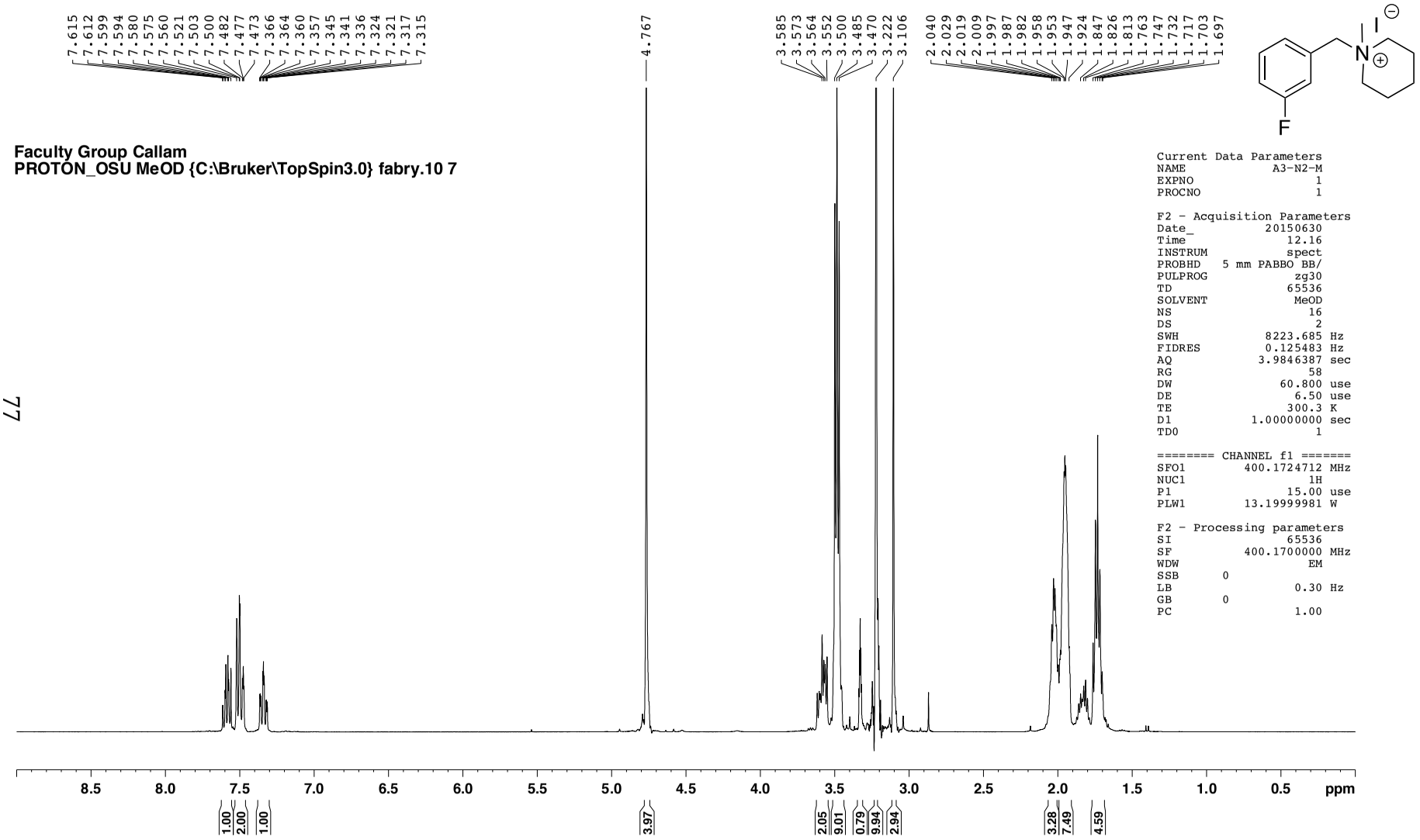


Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 5

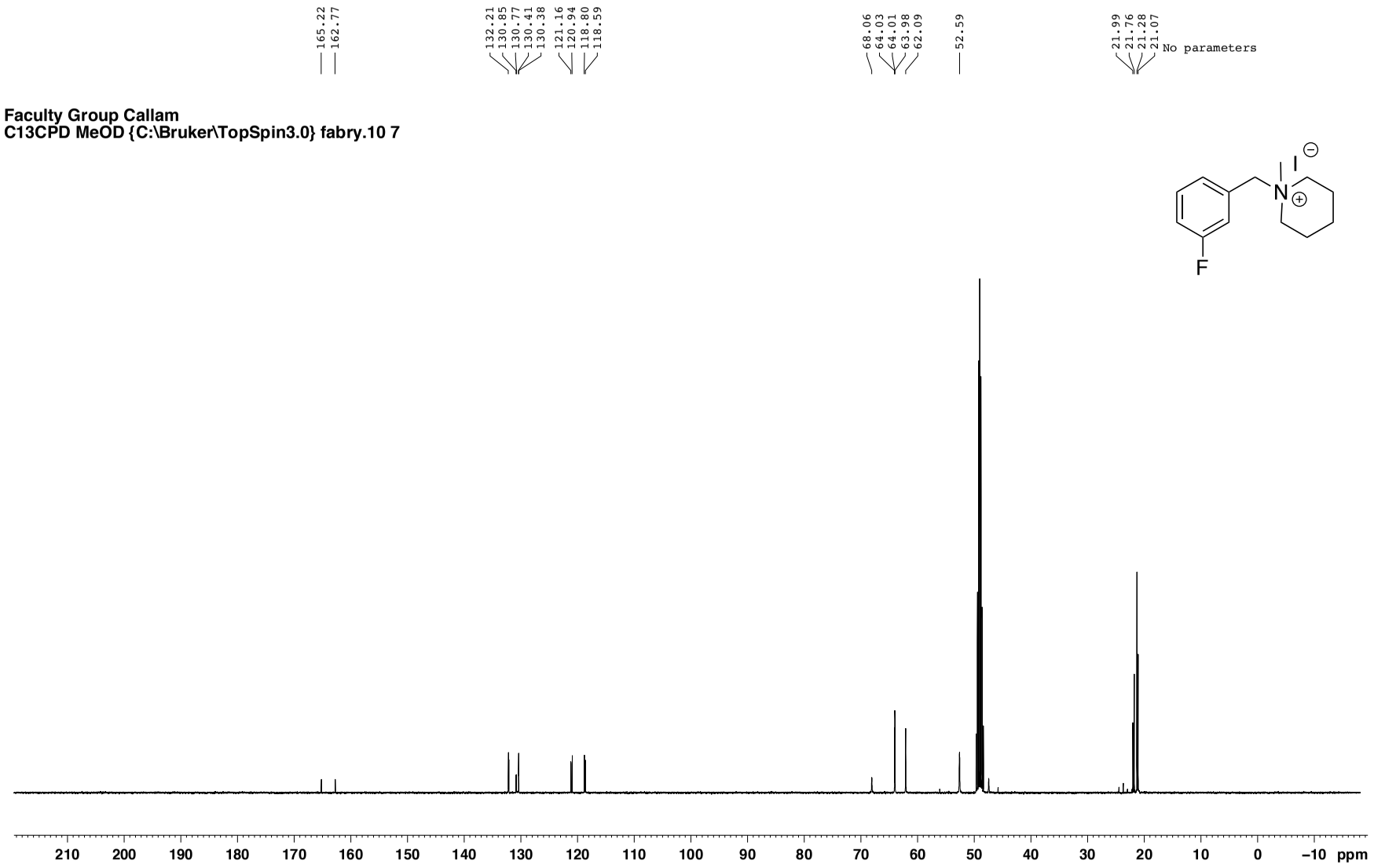
```
Current Data Parameters
NAME                  A3-N5-H
EXPNO                       1
PROCNO                      1

F2 - Acquisition Parameters
Date_              20150629
Time                  16.14
INSTRUM               spect
PROBHD    5 mm PABBO BB/
PULPROG                zg30
TD                    65536
SOLVENT                MeOD
NS                       16
DS                        2
SWH                8223.685 Hz
FIDRES            0.125483 Hz
AQ                3.9846387 sec
RG                    32.11
DW                   60.800 use
DE                    6.50 use
TE                   300.5 K
D1              1.00000000 sec
TD0                       1

======== CHANNEL f1 =======
SFO1           400.1724712 MHz
NUC1                    1H
P1                   15.00 use
PLW1          13.19999981 W

F2 - Processing parameters
SI                    65536
SF             400.1699912 MHz
WDW                     EM
SSB       0
LB                    0.30 Hz
GB        0
PC                    1.00
```

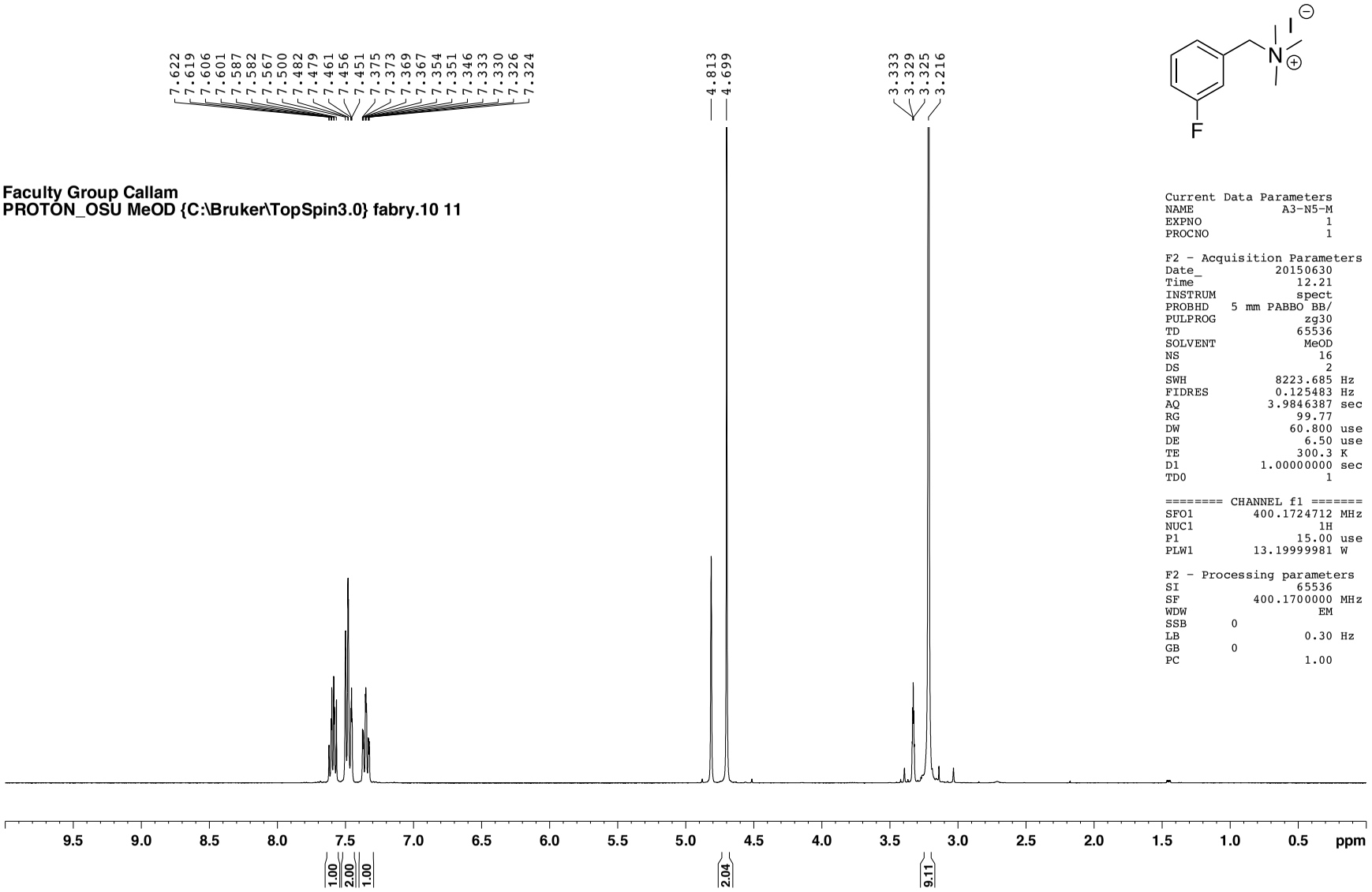


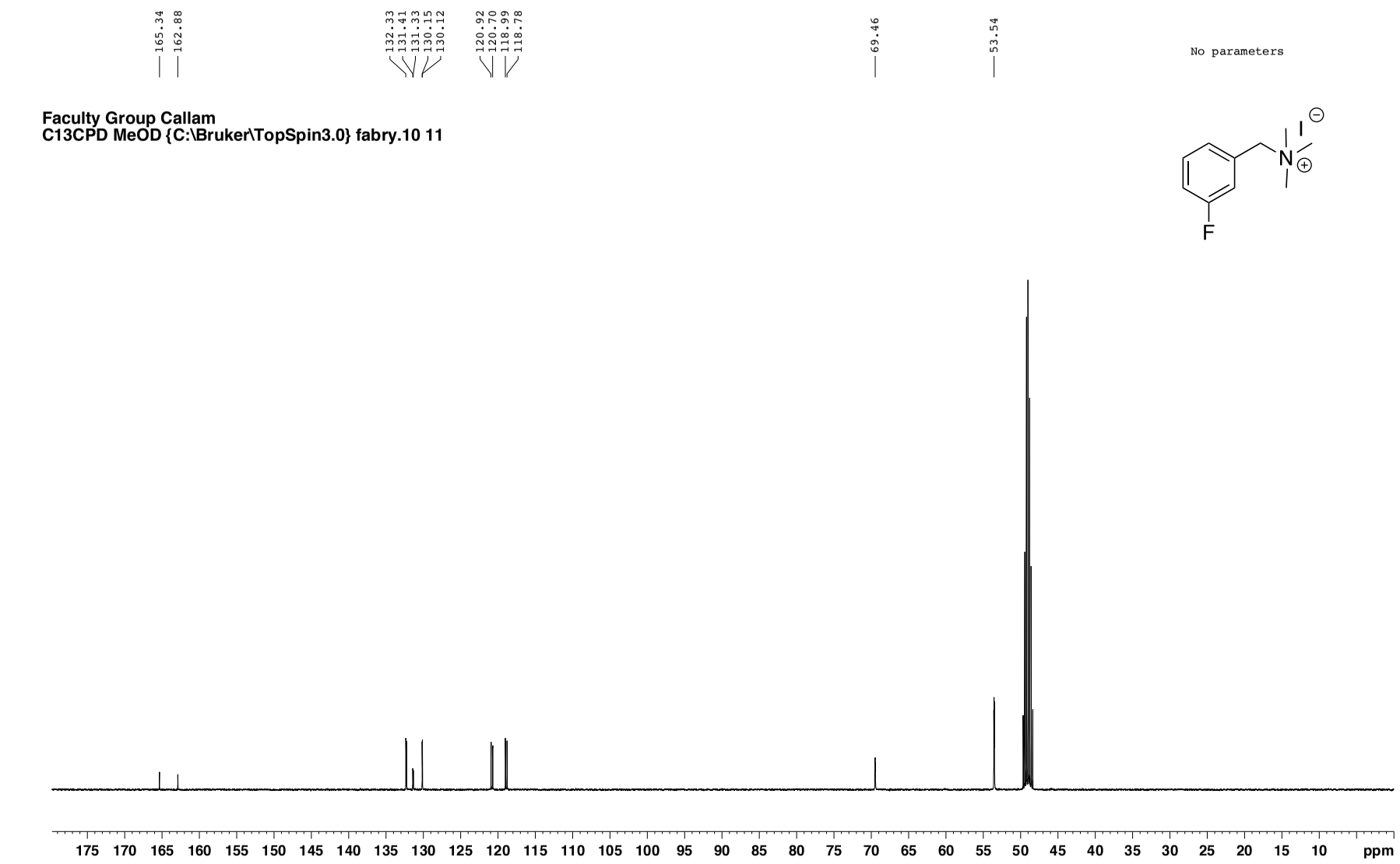

165.47
163.02
133.50
132.37
128.06
118.98
118.75
118.15
117.94
61.28
61.27
43.08
No parameters
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 5
H
Cl
N
F
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
ppm


7.615
7.612
7.599
7.594
7.580
7.575
7.560
7.521
7.503
7.500
7.482
7.477
7.473
7.366
7.364
7.360
7.357
7.345
7.341
7.336
7.324
7.321
7.317
7.315
4.767
3.585
3.573
3.564
3.552
3.500
3.485
3.470
3.222
3.106
2.040
2.029
2.019
2.009
1.997
1.987
1.982
1.958
1.953
1.947
1.924
1.847
1.826
1.813
1.763
1.747
1.732
1.717
1.703
1.697
N
I
F
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 7
Current Data Parameters
NAME A3-N2-M
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150630
Time 12.16
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 58
DW 60.800 use
DE 6.50 use
TE 300.3 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1700000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.00
2.00
1.00
3.97
2.05
9.01
0.79
9.94
2.94
3.28
7.49
4.59

77


165.22
162.77
132.21
130.85
130.77
130.41
130.38
121.16
120.94
118.80
118.59
68.06
64.03
64.01
63.98
62.09
52.59
21.99
21.76
21.28
21.07
No parameters
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 7
F
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
ppm


7.622
7.619
7.606
7.601
7.587
7.582
7.567
7.500
7.482
7.479
7.461
7.456
7.451
7.375
7.373
7.369
7.367
7.354
7.351
7.346
7.333
7.330
7.326
7.324
4.813
4.699
3.333
3.329
3.325
3.216
F
Faculty Group Callam
PROTON_OSU MeOD {C:\Bruker\TopSpin3.0} fabry.10 11
Current Data Parameters
NAME A3-N5-M
EXPNO 1
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150630
Time 12.21
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT MeOD
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 99.77
DW 60.800 use
DE 6.50 use
TE 300.3 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 =======
SFO1 400.1724712 MHz
NUC1 1H
P1 15.00 use
PLW1 13.19999981 W
F2 - Processing parameters
SI 65536
SF 400.1700000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.00
2.00
1.00
2.04
9.11


165.34
162.88
132.33
131.41
131.33
130.15
130.12
120.92
120.70
118.99
118.78
69.46
53.54
No parameters
Faculty Group Callam
C13CPD MeOD {C:\Bruker\TopSpin3.0} fabry.10 11
I
N
F
175 170 165 160 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 ppm